THE UNIVERSITY OF CONNECTICUT

THE SCHOOL OF BUSINESS ADMINISTRATION

NASA Technology Utilization Project

Feasibility Study for Establishment of Regional Dissemination Center for New England

FINAL REPORT

April 21, 1967

Prepared by

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SUMMARY AND RECOMMENDATIONS

This document reports the results of the feasibility study performed by the University of Connecticut, under NASA Contract No. NSR 07-002-015, to investigate and evaluate the establishment of a regional dissemination center in New England to promote the transfer of aerospace generated technology into the region's economy.

Careful analysis of New England's economy together with a detailed study of a cross-section of New England industry is shown to demonstrate a vital need for the NASA Technology Utilization Program. Intensive interviews with top management and an extensive survey of the technological and corporate characteristics that potentially affect technology transfer and the utilization of externally derived knowledge have identified five categories of firms requiring unique services from a regional dissemination center.

The University of Connecticut is found to provide a strong base from which to serve New England in the role of a NASA regional dissemination center. An evaluation of industrial support for the proposed center determined that widespread support exists in the region at both the industrial and state government levels.

Proposed service packages and operational economics are examined in depth and based on cost/income projections; the proposed center should become self-supporting within three years. As part of this analysis various computer programs and configurations were evaluated and the alternatives defined. Manual search techniques were evaluated and found to be uneconomical in the long run, in addition to having very serious drawbacks in depth of indexing, quality control and staffing problems.

It is recommended that NASA establish a regional dissemination center at the University of Connecticut to help fill the unmet needs of New England industry for technology. This course of action would further the NASA objective of increasing technology utilization in the non-aerospace sector of the economy. The unique organizational structure proposed, the services packages designed to serve all parts of industry and the nature of the many, small, technically oriented firms in the region are the ingredients of what should prove to be highly successful experiment for the Technology Utilization Program.

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ANALYSIS OF NEW ENGLAND'S

NEEDS FOR TECHNOLOGY

I.A. ECONOMICS OF REGION

I.A.1. General Economic Trends in New England

That New England has a mature economic structure is a recurring theme in studies of the region. Among data cited supporting this conclusion is the ever-increasing proportion of the labor force employed in service industries relative to manufacturing and primary industries. Projections into the future forecast continuing movement in this direction as shown in Table 1. To the extent that this shift is occurring faster in New England than in the United States as a whole, the region may be said to have a more mature economy than the nation.

Accompanying this shift in employment between broad categories is a changing composition of the manufacturing segment of New England industry. Early industrialization in the nondurable goods of textiles and leathers is yielding to electronics and machinery as principal members of New England industry. Table 3 gives some indication of the greater importance to New England of the latter groups (SIC 35 and 36) compared to the former (SIC 22 and 31). Table 4 suggests their future relationship as machinery and electronics in 1980 add three times the value added to New England's Regional total as may be expected of textiles and leathers, which comparison was two times in 1960.

This transition to durable goods industries nicely reinforces the broader shift to greater employment in service groups. The reason is that the manufacturing segments of emerging importance are more directly technology based than those industries on the decline (see Table 6). There is a greater reliance on the skills of professional and technical groups in these industries - which groups one finds associated with the universities of the region.

This transition within manufacturing carries with it two prospects for New England.[1] One is an expectation of greater economic stability which seems to have been manifested during the 1960-1961 recession.

The second prospect is continued economic growth, as indicated in Table 4, since the emerging industries are considered to be the growth segments of the nation's manufacturing effort. Table 5, however, suggests that the relative importance of New England in each of the segments will decline. The population shift westward is a major factor contributing to this loss; together with the regions few natural resources.

It appears that the composition of New England industry in 1980 will be significally different from 1967 as technology presents itself as a competitive tool.

[1]Edwin F. Estle, A Summary of the New England Economy: Past, Present and Future, Federal Reserve Bank of Boston, 1966, Page 3.

TABLE 1

Employment by Broad Industry Segments
(% of New England labor force
employed in each industry)

Segment	1960	1980
Agriculture, Forestry and Fisheries	2.1	1.6
Mining	.1	.1
Construction	5.0	5.5
Manufacturing	34.1	30.3
Transportation, Communication, Utilities	5.0	3.1
Wholesale and Retail Trade	15.5	16.1
Finance, Insurance and Real Estate	4.2	5.4
Services	15.7	21.6
Government	7.1	8.9
Nonclassifiable	4.1	3.2
Unemployed	4.5	4.1

Source: Arthur D. Little, Inc. Projective Economic Studies of New England , 1965

TABLE 2

The Selected Industries Related to SIC Codes

SIC Code	Industry Group
22	Textile Mill Products
26	Paper and Allied Products
28	Chemical and Allied Products
30	Rubber and Misc. Plastics Products
31	Leather and Leather Products
33	Primary Metals Industries
34	Fabricated Metal Products
35	Machinery, except Electrical
36	Electrical Machinery, Equipment and Supplies
37	Transportation Equipment

TABLE 3

Status of the Selected Industries 1963

SIC Code (See Table 2)	# of Firms	Employment (1,000)	Value Added ($1,000 : 1963)
22	1,094	102.1	746.3
26	647	69.5	800.3
28	771	31.4	592.2
30	557*	40.0+*	-NA-
31	968	99.7	584.3
33	602*	50.0+*	-NA-
34	2,498	92.7	954.3
35	2,998	151.8	1,653.5
36	980	161.7	1,631.4
37	427*	50.+*	-NA-
Total for Group	11,542	848.9	6,962.3+*
Total for New England	24,361	1,428.8	13,535.5
% Group of New England	47.4	53.5	51.4

* This figure should be greater, obviously.

Source: 1963 Census of Manufactures, U. S. Department of Commerce

TABLE 4

Projections of Value Added and Employment for Selected Industries

SIC Code (Table 2)	Employment (1,000) Actual 1960	1980	Value Added (millions of 1954 dollars) Actual 1960	1980
22	125.4	62.6	819	1,025
26	72.7	80.4*	**	**
28	34.6	37.1	475	1,156
30	61.6	76.1	548	1,227
31	104.5	88.1	527	718
33	55.1	50.0	454	614
34	116.2	136.0	767	1,213
35	162.1	219.0	1,215	2,206
36	167.4	269.0	1,177	2,864
37	119.2	126.0	845	1,191

Total New England Employment	1960	1980
	4,331.5	5,617.0

* Source: U. S. Forest Service

** Not computed by A. D. Little, Inc.

Source: Arthur D. Little, Inc.; *Projective Economic Studies of New England*: 1965

TABLE 5

New England Value Added by Two-digit Industry as a Percentage of U. S.

SIC Code (See Table 2)	1960 (Actual)	1980
22	14.3	10.9
28	3.4	3.1
30	14.5	12.7
31	30.2	28.5
33	4.9	4.1
34	8.5	7.8
35	10.6	9.2
36	10.4	10.2
37*	48.9	45.7

* Figures are % of Prime Contract Award which is Value Added in New England.

Source: Arthur D. Little, Inc.: <u>Projective Economic Studies of New England</u>. 1965

TABLE 6

Research and Development Activities in the Selected Industries Segments - U. S.

SIC Code	Cost of R&D* ($1,000)	# of Employees in R&D Testing
22	12,044	1,272
26	71,410	3,170
28	569,713	39,472
30	22,619	1,552
31	783	20-99
33	105,008	4,972
34	90,386	5,566
35	353,630	18,742
36	949,862	36,001
37	563,032	33,021
Total for Group	$2,738,492	145,467
All Manufacturing Total U. S.	$3,172,620	-NA-

* Some industries may rely on material or equipment suppliers for technical support - e.g. corfam.

Source: 1963 Enterprice Statistics
U. S. Department of Commerce

TABLE 7

SIC Code	Total Number in New England Reporting Units	Employees
19	32	14,194
20	2,358	75,754
21	16	316
22	1,066	101,137
23	1,654	83,542
24	2,667	27,663
25	662	21,595
26	645	68,585
27	2,416	70,251
28	756	30,937
29	95	1,918
30	645	64,878
31	957	97,938
32	798	25,374
33	611	59,562
34	2,502	91,701
35	3,017	151,581
36	976	161,533
37	475	110,095
38	392	49,299
39	1,623	67,079
TOTAL	24,363	1,374,932

Source: County Business Patterns 1963
U. S. Department of Commerce

Highlights of the changes in industrial activity that are expected to take place in the individual New England states by 1980 are described below. The source of the predictions is the 1965 A. D. Little, Inc. report entitled, Projective Economic Studies of New England.

Massachusetts:

Massachusetts has for many years accounted for approximately half of all New England's economic activity. Projective Economic Studies of New England indicates that the Bay State should continue to maintain this share when gauged in broad measures of population, total income, and personal income.

It is quite evident that the nearly three-fold expansion in the level of output projected for the Electrical Machinery industry between 1960 and 1980 overshadows even the substantial output gains forecast for the other industries.

Connecticut:

In terms of volume, Connecticut's economic activity ranks second after Massachusetts' among the New England states. Connecticut provided approximately one-fourth of New England's employment in 1960. During the last twenty years, Connecticut was also the fastest-growing New England state in employment, population and personal income. Projections indicate a further slight increase in Connecticut's share of these major economic factors. Connecticut will continue to be the second largest state in economic activity.

In Connecticut, the value of output in 1980 will be greatest in Electrical Machinery, followed by Non-electrical Machinery and Chemicals. The fastest-growing output in Connecticut will be in the Chemical industry, in which output in 1980 will be three times as great as that in 1960. Electrical Machinery will experience a two and one-half increase in output over this period while the increase in other machinery output will be twofold.

Maine:

The largest of the six New England states in terms of area, Maine, now ranks third in population and employment and fourth in personal income. In part, this reflects the fact that the primary resource industries, e.g. Fisheries and Agriculture, continue to employ a proportionately greater share of the state's labor force than in most other New England states.

Output measured in value-added terms (constant dollars) is projected to rise fastest in Maine's Electrical Machinery and Chemical industries. This will occur largely as a result of rising levels of productivity in these industries and the influx of new firms into the state. Other industries for which significant production gains are forecast are Non-electrical Machinery and Paper Products.

Rhode Island:

Although accounting for only eight to nine percent of New England's total economic activity over the past twenty years, Rhode Island is one of the most heavily industrialized, densely populated, and highly urbanized states in New England and the nation. The projected decline in Rhode Island's share of total New England economic activity over the next fifteen years can be explained in part by Rhode Island's present high level of economic development.

Output in the major industries (as measured in 1954 constant dollar, value-added terms) is projected to grow most rapidly in the Chemical and Electrical Machinery industries. Nevertheless, by 1980, output volumes are in many instances likely to be one-half the individual output level recorded for Connecticut and Massachusetts in 1960.

New Hampshire:

For the last twenty years New Hampshire has ranked fifth among New England states in major economic measure, accounting for roughly 6 percent of the region's employment. The study finds that in the next fifteen years, it will be second only to Connecticut in growth rate in New England.

Output projections (in 1954 dollars) for major industries in New Hampshire indicate a four-fold increase in Electrical Machinery, from $55.5 million in 1960 to $228 million in 1980. The other four industries listed will also grow, but less dramatically than Electrical Machinery.

Vermont:

The history of Vermont's economic development follows a course similar to that of other New England states. The important difference is that in Vermont the pace of transition from an "extractive" to a "processing" and then to a "service" economy has proceeded more slowly than in other New England states.

Thus, Vermont's resource industries (principally Agriculture and Mining) still employ a disproportionately large share of the state's work force, compared with resource industries of other New England states. In this respect, moreover, the gap between Vermont and other New England states has widened rather than narrowed over the last three decades. Although this factor will continue to exert a somewhat dampening influence on Vermont's future industrial growth, significant changes in the state's socio-economic structure are forecast.

For the five major industries for which output projections were derived, production levels will rise most rapidly in the Machinery industries. Relatively small output increases are forecast for the Primary Metals and Transportation Equipment industries.

At this point let us turn from geographic economic projections to those for the major industrial groups in New England.

An extensive bibliography dealing with problems of technology transfer can be found at the conclusion of this report.

I.A.3. Projected Major Industrial Trends

As mentioned above, one of the characteristics that potentially may affect the technology transfer process in an industry is the economic trend or outlook for that industry and for the region in which it may be represented. Accordingly we have exerpted relevant passages from the Arthur D. Little, Inc. study of 1965 entitled Project Economic Studies of New England. The following material will deal with trends in nine of the region's more important industrial groups and will provide, along with the preceding discussion, an economic backdrop upon which we will sketch the potential impact of making the NASA technology resource available to all facets of industry in New England.

SIC 22 - Textile Mill Products. The textile industry has occupied a major though declining position in New England's economy. In 1947 it still employed more persons than any other 2-digit manufacturing industry in New England and produced 24 percent of the country's total textile output.[1] Since 1947, however, employment and output in New England have been declining both relatively and absolutely. By 1962, employment was less than one-half its 1947 level, while New England's share of national output had declined to 14 percent. The decline in employment was accelerated, moreover, by substantial increases in productivity resulting from high levels of investment in new equipment and machinery during the postwar period.

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1 Based on value added data.

As seen below, the structure of the textile industry at both the New England and U. S. levels is dominated by components closely linked to the apparel industry. The industrial use of textiles is both small and declining, reflecting the substitution of paper and plastics for such uses as packaging and automobile interiors.

SIC 22
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Components	New England	United States
221	Broad Woven Fabric Mills, Cotton	9.8	22.2
222	Broad Woven Fabric Mills, Man-made Fiber and Silk	8.1	9.6
223	Broad Woven Fabric Mills, Wool (including Dyeing and Finishing)	21.0	6.9
224	Narrow Fabrics and Other Small-wares Mills: Cotton, Wool, Silk, etc.	7.7	2.9
225	Knitting Mills	10.0	22.7
226	Dyeing and Finishing Textiles, except Wool Fabrics and Knit Goods	13.3	9.4
227	Floor Covering Mills	2.6	5.4
228	Yarn and Thread Mills	11.5	10.6
229	Miscellaneous Textile Goods	16.0	10.3
	TOTAL PERCENT	100.0	100.0

SIC 28: Chemicals and Allied Products. - The region's chemical industry is relatively small, both in comparison with the U. S. chemical industry and in the context of employment in all other industries in New England. For the most part, it is made up of a large number of specialty manufacturers who were established in response to the needs of the shoe and textile industries. Since the decline of the latter two industries in the past fifteen years, the New England chemical industries built around them have had to gear their talents to produce new products for new customers.

Because of strong compositional differences, the New England chemical industry was not functionally related to the national industry at the 2-digit level. The table below illustrates the disparities in industrial structure between the New England and the U. S. chemical industries.

SIC 28
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Component	New England	United States
281	Basic Industrial Chemicals	14.9	34.0
282	Plastics, Synthetic Rubber and Fibers	19.8	15.4
283	Drugs	13.4	17.5
284	Cleaning and Toilet Goods	33.7	16.1
285	Paints and Varnishes	6.5	5.9
286	Gum and Wood Chemicals		
287	Agricultural Chemicals	11.7	11.1
289	Other Chemical Products		
	TOTAL PERCENT	100.0	100.0

The projections of employment obtained from the projections of output and productivity result in a doubling of persons employed in the industry in New England by 2020, compared with a 25 percent increase in the 1950-60 period.

SIC 30: Rubber and Miscellaneous Plastics Products - Rubber and Plastics Products is one of the fastest growing industries in the U.S. and New England. At the present time, the industry has a relatively high concentration in New England. In the future expectations are that the New England industry will grow less rapidly than the U.S. industry and New England's share of the industry will decline accordingly. This is in keeping with historical trends.

The 3-digit composition of the rubber industry for New England and the U.S. is indicated below:

SIC 30
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Component	New England	United States
301	Tires and Inner Tubes		
302	Rubber Footwear	33.8*	41.2
303	Reclaimed Rubber		
306	Fabricated Rubber Products, not Elsewhere Classified	38.6	30.4
307	Miscellaneous Plastics Products	27.5	28.3
	TOTAL PERCENT	100.0	100.0

*Information of individual 3-digit New England industries in this group was not available.

The most significant factor in the structure of both the regional and national industries is the growing importance of the plastics products component. Between 1947 and 1960, the plastics share of the industry more than doubled. By 2020 expectations are that plastics will account for over one-half of the industry.

These employment projections indicate a continued expansion in rubber and plastics employment in New England at a rate in keeping with the 15 percent increase recorded by the industry between 1950 and 1960.

SIC 31: Leather and Leather Products - The leather products industry in New England has a larger share of the industry's national output than does any other New England 2-digit manufacturing industry. This share has also been remarkably stable, remaining at about 30 percent since 1947.

The New England composition of the industry, as outlined in the table below, closely parallels the industry's national composition. The dominant component of the industry for both New England and the nation is Footwear, Except Rubber (SIC 314).

SIC 31
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Component	N.E.	U.S.
311	Leather Tanning and Finishing	15.0	14.5
312	Industrial Leather Belting and Packing	0.8	1.9
313	Boot and Shoe Cut Stock and Findings	9.5	5.2
314	Footwear, except Rubber	66.8	60.4
315	Leather Gloves and Mittens	0.1	1.4
316	Luggage	1.5	5.1
317	Handbags and Other Personal Leather Goods	5.8	9.9
319	Leather Goods, not Elsewhere Classified	0.4	1.6
	TOTAL PERCENT	100.0	100.0

The resulting projections of national output grow at about the same rate as population, reflecting the high dependency of the industry upon the growth in footwear demand. The introduction of new synthetic shoe leathers (i.e. Corfam, etc.) may result in a decline of the Leather Tanning and Finishing Industry (SIC 311) which accounts for about 15 percent of the industry's total output.

Employment in the New England leather industry has undergone a small decline in the postwar period. This decline has been due to productivity increases since, as previously noted, the industry's share of national output has been stable. The employment projection implied by the value added and productivity projections indicates a continued moderate decline in New England's employment in the industry as output per employee continues to rise faster than the demand for leather products.

SIC 33: Primary Metals. - The primary metals industry has been a small and declining industry in the New England region. Between 1947 and 1961 employment declined by 25 percent. Expections are that this decline will continue in the projection period. Unlike the national industry which is dominated by iron and steel, the New England industry is concentrated in certain of the nonferrous components. Nonferrous Rolling and Drawing (SIC 335) is especially important, accounting for over one-half of the region's primary metal output. The special structure of the industry in New England is indicated in the table below.

SIC 33
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Component	N.E.	U.S.
331	Steel Rolling and Finishing	17.5	55.4
332	Iron and Steel Foundries	7.5	10.8
333	Primary Nonferrous Metal	.1	7.4
334	Secondary Nonferrous Metal	1.8	1.5
335	Nonferrous Rolling and Drawing	60.0	16.6
336	Nonferrous Foundries	4.9	4.5
339	Primary Metals, not Elsewhere Classified		3.9
	TOTAL PERCENT	100.0	100.0

SIC 34: Fabricated Metals. - In 1960 the fabricated metals industry accounted for about 3 percent of New England's total employment. Estimates for 2020 indicate that the industry will show little change in its share of total New England employment.

At the national level, output for this industry is projected to grow less rapidly than the economy as a whole. The New England industry, in turn, is projected to grow at a slightly lower rate than the U. S. industry, as is borne out by past historical trends.

SIC 34
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Component	N.E.	U.S.
341	Metal Containers	1.1	6.4
342	Cutlery, Hand Tools and Hardware	32.4	13.7
343	Plumbing and Nonelectric Heating	2.3	7.4
344	Structural Metal Products	13.2	28.5
345	Screw Machine Products and Bolts	16.9	8.9
346	Metal Stampings	9.7	11.9
347	Coating, Engraving and Allied Services	5.3	4.7
348	Fabricated Wire Products	4.3	5.1
349	Miscellaneous Fabricated Metal Products	14.6	13.3
	TOTAL PERCENT	100.0	100.0

It can be seen that New England's industry specializes more in light industry components such as Cutlery (SIC 342) and Screw Machine Products (SIC 345), while the national industry shows a greater concentration in such categories as Structural Metal Products (SIC 344).

<u>SIC 35: Nonelectrical Machinery</u>.- The nonelectrical machinery industry is an old and relatively stable industry in New England, accounting for a significant share of the region's manufacturing employment. The composition of the industry, as shown below, is highly concentrated at the regional level in the industrial machinery sectors (SIC's 354, 355, and 356).

SIC 35
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Components	N.E.	U.S.
351	Engines and Turbines	10.5	8.6
352	Farm Machinery and Equipment	0.3	8.8
353	Construction and Mining Machinery	1.5	16.6
354	Metalworking Machinery	14.7	16.6
355	Special Industry Machinery	18.1	10.8
356	General Industrial Machinery	14.5	15.6
357	Office, Computing and Accounting Machinery	2.9	7.8
358	Service Industry Machinery	7.0	7.4
359	Miscellaneous Machinery	7.1	7.7
	TOTAL PERCENT	100.0	100.0

The regional components of the industry have not grown equally. For example, Agricultural Machinery (SCI 352), Metalworking Machinery (SIC 354) and Service Industry Machinery (SIC 358) have experienced absolute declines in value added, whereas Engines and Turbines (SIC 351) and Miscellaneous Machinery (SIC 359) have exhibited substantial growth. The growth of the remaining components has varied depending on the time period selected.

The continued increases in the level of employment projected for this industry secure its rank as a major employer in the New England region, although its first place position has already been yielded to the rapidly expanding electrical machinery industry.

SIC 36: Electrical Machinery.- Electrical Machinery is a burgeoning industry in both New England and the U.S. Projections indicate that the New England industry as well as the national industry will grow at nearly the same rate in the future, i.e., New England's share of the U.S. industry will remain approximately the same.

In terms of employment, Electrical Machinery represented the largest single manufacturing industry in New England in 1960, accounting for a little over 4 percent of New England's total employment. Over the projection period this share is expected to rise by more than 25 percent, with the industry thus accounting for about 5½ percent of total New England employment by 2020.

SIC 36
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Component	N.E.	U.S.
361	Electric Transmission and Distribution Products	16.0	11.4
362	Electric Industrial Apparatus	4.0	12.7
363	Household Appliances	9.6	15.9
364	Lighting and Wiring Devices	15.9	10.4
365	Radio & T.V. Receiving Equipment	3.0	7.4
366	Communication Equipment	23.9	20.4
367	Electronic Components		
369	Electrical Products, not elsewhere Classified	27.5	21.9
	TOTAL PERCENT	100.0	100.0

The table shows that New England has a relatively higher concentration in Electric Transmission Products (SIC 361) and Lighting and Wiring Devices (SIC 364) than the national industry in which the concentration is greater in Electrical Industrial Apparatus (SIC 362), Household Appliances (SIC 363) and Radio and Television Receiving Equipment (SIC 365).

SIC 37: Transportation Equipment. - The transportation equipment industry in New England can be identified as primarily a defense-oriented industry. As the table below indicates, over 90 percent of the value added in New England's SIC 37 is in aircraft and shipbuilding. Motor vehicles, although very important in the industry nationally, are of little significance in New England.

SIC 37
INDUSTRY COMPOSITION, 1958
(percent distribution of value added)

SIC	Industry Component	N.E.	
371	Motor Vehicles and Equipment	6.2	44.2
372	Aircraft and Parts	68.2	45.3
373	Ship and Boat. Boat Building	24.4	7.0
374	Railroad Equipment	- -	2.1
375	Motorcycles and Bicycles	1.3	0.3
379	Miscellaneous (Mobile Homes, etc.)	- -	1.1
	TOTAL PERCENT	100.0	100.0

In 1960 New England's share of prime military contracts was 10.1 percent. We expect this share to decline gradually to New England's projected population share of 5.0 percent by the year 2020. At the same time, defense spending as a proportion of GNP is also expected to decline relatively. The combination of these two factors serves to dampen the projected rates of increase in output and employment in the New England transportation equipment industry relative to the postwar period.

SUMMARY OF GROWTH PATTERNS

Each export industry, as a result of the location quotient analysis,[1] is classified as either growing, stable, or declining. An industry is classified as growing if its employment has been increasing. Generally, an increase in an industry's employment is accompanied by an increase in its percent share of New England's total employment, although its location quotient and share of national employment in the same industry might be declining. In such a case, the industry is growing at a slower rate in New England than in the nation as a whole.

At the other extreme, an industry's employment might be declining in New England and in the U.S. while its percent share of the same industry in the nation has been increasing. This would only indicate that the industry is declining less rapidly in New England than in the nation as a whole. An example is the leather and leather products industry (SIC 31), which is classified as declining.

Stable industries were defined as those which do not exhibit any clear trend either upward or downward. Such industries may show considerable fluctuations in employment, yet no clearcut trend in either direction. Employment in the ordnance and accessories industry (SIC 19) is an example.

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1 Location quotient is the ratio of the industry's employment in New England to total employment in New England over the ratio of the industry's employment in the U.S. to the total employment in the U.S. When this quotient exceeds unity the industry is considered to be an "export" industry.

a. Growing Industries. -

SIC 30, rubber and plastics products employment has been increasing. The relative importance, as measured by the location quotient, has been fairly stable at about 2.4, with no trend in either direction. With roughly 65,000 employees, the industry has approximately 2% of New England employment on its payrolls. Nearly one fifth of U.S. employees in the industry work in New England.

SIC 36, electrical machinery has experienced a 50% increase in employment since 1950. The steadiness or slight decline of the location quotient indicates a similar rapid growth of the industry throughout the nation. The industry's share of New England employment has been increasing and stood at over 4.0% by 1960. That year the regional industry employed 11% of all workers in the national industry.

SIC 38, professional, scientific and controlling instruments photographical and optical goods; watches and clocks, employed about 50,000 persons in 1962. This employment was roughly 1.5% of total New England employment and 14% of total U.S. employment in the industry. The relative concentration measured by the location quotient is fairly constant at somewhat over 2.0 (measured on a total employment base.)

b. Stable Industries. -

Manufacturing employment has no trend in either direction which is consistent among the four sources. The relative concentration is either constant or slightly declining, according to location quotients. As percent of both total New England employment and of U.S. manufacturing employment, New England manufacturing employment is declining.

SIC 19, ordnance and accessories; Employment in 1961 was almost double that in 1947. The relative importance of the New England industry has declined because of even more rapid growth in the rest of the nation. The location quotient dropped from 4.0 in 1947 to 2.0 in 1961, with a low point of 1.2 in 1953. The industry's percent of New England employment has increased since 1947, but was still under 1% by 1961. New England employment in the industry as a per cent of national employment in SIC 19 has declined from 55 % in 1947 to 15% in 1961.

SIC 26, paper and allied products, reached a peak employment in 1956 and declined somewhat between that year and 1962. The location quotient has remained steady at 1.8 (on a total employment basis). The industry's share of New England employment has remained fairly steady at about 2.3%, while its share of employment in the national industry has declined from about 15% in 1947 to 12% in 1961.

SIC 34, fabricated metals, barely holds its own as an export industry with a minimum location quotient in most instances. Its share of New Endland employment is roughly 3% growing or declining, depending upon which source is consulted. The New England industry's share of national industry employment is declining and has been roughly 9.0% in recent years.

SIC 35, machinery except electrical, has an employment of over 160,000. The location quotient has been fairly stable at 1.7 since the early 1950's. The industry's share of New

England employment is about 4.0 % and has been declining over the past decade. The New England industry's share of employment in the national industry is roughly 10% and has been declining gradually since 1947.

c. Declining Industries. -

SIC 22, textiles, has shown a substantial decline. Employment is roughly one half of what it was twenty years ago. Most of the decline occurred after 1950. Since 1958, the downward trend has been much more gradual than it was in the early 1950's. The location quotient has declined but is still quite high at 2.0. The industry's share of New England employment is now 3% and its share of the national industry is 13%.

SIC 31, leather and leather porducts, as noted earlier, is a declining industry which is becoming relatively more concentrated in New England, since the regional industry is not losing employment as quickly as the national industry. The decline is considerably smaller than that in the textile industry. In 1962, there were approximately 110,000 workers employed by the leather industry - roughly 3.0 % of total New England employment. The regional industry employs nearly one third of all workers in the national industry and has a location quotient of about 4.7 on a total employment basis.

SIC 39, miscellaneous, includes jewelry and silverware and costume jewelry and notions. Employment in the industry division has declined steadily since 1947. There was a slight increase between 1959 and 1962. The industry employs about 2.0% of all New England workers and 16% of all those in the national industry

Can a firm or region's utilization of technology be measured? Economic studies which attempt to translate expected expansion of industrial output into expected employment levels depend upon productivity assessments as the linking quantity. The common measure of productivity is value added per employee or man-hour or some relative of these figures. To make these productivity assessments require some understanding of the industry of interest. That is to say, what is contributing to realization of the present level of worker productivity? What, then, are the factors which appear likely to change?

Initially one is tempted to search technological changes for the principal reasons for productivity changes. This connection is simply not direct nor clearcut, especially in the short term. Even when the definition of technology is expanded to include improved management techniques as well as new processes or new products, there remains no direct relationship. Labor skills, special market considerations and other factors may affect apparent productivity. In fact when a technological advance creates a new product, it is highly unlikely that the first productivity figures will be the best achieved during the life of the product - modifications of process and economics of scale as demands grow are among influences on productivity figures of new products, and old.

Even if technological influences could be separated from all others, it is impossible to construct individually meaningful measures. How do available figures differentiate firms which employ modern equipment inefficiently from those which use somewhat obsolete equipment very efficiently. So-called "typical" balance sheets and income statements are available from trade associations or magazines to describe generally firms of various sizes in their industries. While it may seem reasonable to compute value-added per-unit of capital employed, labor productivity or other figures, these only become somewhat reasonable in a case-by-case analysis in which product mixes, overtime rates and other factors are considered. A furniture firm may recognize more modern production techniques but they may be incompatible with its product line of very fine furniture.

Therefore, technological measures only begin to have significance in combination with qualitative factors. This is recognized by economic projections which wisely do not attempt to step beyond gross assessments of industry productivity movements as more than results of many inter-related influences, including technology: "Productivity varies with industry with the amount of investment, past and present; with the adaptiveness of management; with native ability, training, and cooperative spirit of workers."[1]

The foregoing discussion overlooks an important point. In addressing itself to measuring present technological utilization

[1]Seymour E. Harris, The Economics of New England, Harvard University Press, Cambridge, 1952, p. 154.

it neglects consideration of a rate or efficiency measure of technology utilization. That is the amount used divided by the amount theoretically available. But this leads to further complications for it assumes that the technology available at any instant of time is fully identified. On the contrary it seems impossible that this could be the case by the very nature of technology transfer. Professor Rosenbloom states it this way, "Analogy underlies all inductive reasoning. It implies the identification of structural or functional identities in otherwise dissimilar situations or things."[2] That is, no direct link between knowledge and application in one and that of another or the same exist.

It is even difficult to quantify the extent to which a firm or industry is attempting to identify the application/knowledge links. Some general indication was given by Table 6 in the previous section, but this says nothing about the extent to which firms or industries rely on trade associations or suppliers of raw material or suppliers of productive equipment for technical support and ideas.[3]

[2] R. S. Rosenbloom, Technology Transfer - Process and Policy National Planing Association, Special Report #62, 1965, p. 11.

[3] Informal discussions were held with various members of the faculty of the Harvard Business School, Arthur D. Little, Inc., and the Federal Reserve Bank of Boston. All emphasized that thoughts on technology must step beyond simple productivity measures. While several quantitative measures were suggested, none suggested that a very accurate nor meaningful picture could be drawn by them.

Can technology seeking companies within industries be identified? Grossly perhaps they could, but the results would have little significance. The comparison must consider what applications have been identitied, how widespread the knowledge is within an industry and the motivation or lack of it to incorporate new technology into a firm's or industry's operation.

Despite the foregoing qualifications that must be applied to any attempt to measure the needs and the potential for technology utilization, we have made an ambitious effort to identify these needs as specifically as possible within New England. This effort is described below.

I.B. Detailed Analysis of New England Industry

The goal of the analysis was to be able to describe New England industries in terms of various factors that might reflect the industries' propensity for technology utilization in general and specifically for various modes of transfer. The characteristics that we have gathered data on are as follows:

I. Technological Characteristics

  A. Relative Importance of R&D Effort in Company

    1. Number of technologists employed

    2. Ratio of technologists to total employment

  B. Fields of Investigation or Interest

  C. Depth of Investigation or Interest
  (Basic or applied research, development, product imporvement, production engineering)

D. Information Gathering Methods

II. Corporate Characteristics

A. Principal Line of Business

B. Diversity of Product Lines

C. Diversity of Products Within Lines

D. Operational Flexibility (job shop, production line, hybrid)

E. Per cent Sales to Government

III. Industry Trends and Characteristics

I.B.1 Data on Technological and Corporate Characteristics

Two basic sources of information were utilized in obtaining information on these characteristics with the exception of category III. The first source used was the Dun and Bradstreet Marketing Service Company which supplied individual firm information on size of employment, four digit standard industrial classifications both primary and secondary, as well as information on net sales and net worth. The second source of data came from the 5100 questionnaires (see Appendix A, exhibit 1) that were mailed to companies and plants throughout New England. These questionnaires supplied the remaining information to us.

Actually two sets of data have been analyzed separately and together. Some 2600 plants (or 11.1%) were drawn from the 23,417 units tabulated in this area by Dun and Bradstreet Marketing Service. This sample represents 10.3 of the total industrial population of New England as defined by the SIC codes listed in Table 7.

The reporting units* to be sampled were drawn on a proportionate basic so that each four digit standard industrial classification was represented in the sample in the same proportion that it exists in the New England region. Within each four digit category, the firms selected for the sample were drawn randomly.

A second set of some 2500 questionnaires was mailed to firms within 150 four digit SIC codes. These codes were selected on the basis of our belief that they represented those segments of New England industry which have the greatest immediate potential for participating in, and deriving benefits from, the NASA Technology Utilization Program. Again, our sample was a proportionate random one which, when combined with the overlaping four digit SIC code firms of the first sample, resulted in a sample size of 30% of the population in each of the 150 categories selected. The response from these 150 categories has been 11.7%

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*The following discussion will use the terms reporting units, plants, firms and companies synonymously although a distinction exists between some of them. The Census data obtained from U. S. County Business Patterns reports actually refers to reporting units in a region. These are defined as a plant location that may comprise theentire company's operations or may be one of many locations. Each location is treated as a report-unit. In actual fact the mean employee size of the reporting units in New England is less than 57 reflecting the small size of the majority of plants. Consequently, more often than not, the reporting unit represents a company.

of the 30% sample or 2.0% of the total population.

A comparison of the response rates of these two samples is shown in Table 8. The hypothesis in selecting the 150 SIC categories for intensive sampling was that these product groups would be most responsive to the Technology Utilization program and would have the most to gain from it. We expected that this postulated interest would be demonstrated by a higher response rate to the questionnaries sent to them. In all respects but one the material sent to the "select" group of four digit SICs was identical to that which was mailed to the proportionate sample of industrial SICs in New England (some 370 four digit classifications are represented in the total groups). The one difference was the color of the paper that the questionnaire was printed on--white for the proportionate 10% sample and blue for the selected sample. Consequently, we would expect the response rates to be equal if there were no difference in interest between the two groups and to be significantly different if there were.

Examination of Table 8 reveals that in aggregate there was little difference in response rates between the two groups. An overall response of 10% was recorded for the proportionate sample and a slightly higher 11.7% rate for theselected SIC groups. However, this difference is not statistically significant--on the basis of statistical inference, the difference observed could could easily occur even if the underlying factors which cause a

Table 8

COMPARISON OF RESPONSE RATE BETWEEN TOTAL POPULATION SAMPLE

AND 150 SELECTED FOUR DIGIT SIC CATEGORIES

SIC Code	Total No. Reporting Units in N.E.	10% Proportionate Sample of Population				30% Sample of 150 Four Digit SIC Categories			
		No. Rptg Unit in Sample	No. Responses	Rspn as % Total	Rspn as % Sample	No. Rptg Unit in Sample	No. Responses	Rspn as % Total	Rspn as % Sample
19xx	29	3	0	0	0	6	0	0	0
20	2,296	245	11	.5	4.5	84	5	.2	6.0
21	11	1	0	0	0	1	0	0	0
22	1,048	107	16	1.5	14.9	106	10	.9	9.4
23	1,549	161	7	.4	4.3	74	3	.2	4.1
24	2,460	261	15	.6	5.7	332	28	1.1	8.4
25	612	68	7	11.4	10.3	55	3	.5	5.5
26	637	65	8	1.3	12.3	33	6	.9	18.2
27	2,328	264	20	.9	7.6	8	0	0	0
28	746	79	14	1.9	17.7	170	24	3.2	14.1
29	79	9	3	3.8	33.3	6	1	1.3	16.7
30	605	68	10	1.7	14.7	213	32	5.3	15.0
31	910	91	6	.7	6.6	237	17	1.9	7.2
32	789	79	7	.9	8.9	63	8	1.0	12.7
33	590	59	9	1.5	15.3	78	13	2.2	16.7
34	2,402	243	28	1.1	11.5	687	94	3.9	13.7

Table 8 (continued)

SIC Code	Total No. Reporting Units in N.E.	10% Proportionate Sample of Population: No. Reptg Unit in Sample	No. Responses	Rspn as % Total	Rspn as % Sample	30% Sample of 150 Four Digit SIC Categories: No. Rptg Unit in Sample	No. Responses	Rspn as % Total	Rspn as % Sample
35	2,826	360	38	1.3	10.6	1,020	109	3.9	10.7
36	925	142	19	2.1	13.4	373	49	5.3	13.1
37	428	57	5	1.2	8.8	151	17	4.0	11.3
38	400	62	12	3.0	1[illegible].4	159	33	8.3	20.8
39	1.747	164	22	1.3	13.4	64	7	.4	10.9
TOTAL	23,417	2,578*	257**	1.1	10.0	3,919*	459**	2.0	11.7

* delivered questionnaires less invalid responses

** combined valid responses totalled 590 which represents 11.9% of total sample (4,976) after deletion of 43 undelivered questionnaires and 82 unusable responses.

response were identical in both samples. Although no meaningful difference may be exhibited between the two samples' response-rates in aggregate, several significant differences may be noted in individual industry groups.

For example, SIC code 22xx, which represents Textile Mill Products, had a much higher response rate from the proportionate sample than was forthcoming from the 2 four digit SIC categories selected for intensive sample coverage. These categories were 2231--"broad woven fabric mills--wool" and 2241--"narrow fabrics and other small wares mills." The implication is that the categories chosen had less interest than the other elements in the industry. In fact, a check of the returns revealed responses in all 3 digit categories and in 40% of the 4 digit categories.

In another example, SIC code 26xx, Paper and Allied Products, the reverse was true. The selected sample, concentrated in 2621--"Paper Mills" had a response rate of 18.2% of the sample whereas the response rate from the proportionate sample was 12.3%. These latter responses were concentrated in only two 3 digit categories 264x and 265x although one response occurred in 2641--"paper coating and glazing" representing an unexpected interest in technology. The strong showing of selected SIC 2621 verifies its inclusion in the 150 high potential product categories.

The SIC category 29xx--Petroleum Refining and Related Industries--shows a marked contrast between the two samples. The magnitude is probably the result of the small size of the population involved but analysis does indicate an area of interest other than the one postulated. The selected 4 digit category was 2911 -"petroleum refining" and only one response was elicited from the reporting units in the region. Interestingly enough the other two responses that occurred from the proportionate sample came from category 2951 - "paving mixtures and blocks," again demonstrating an unexpected area of interest. On the other hand, no response was forthcoming from SIC 2992--"lubricating oils and greases" although this category was one of the 150 selected.

Inasmuch as one of the industrial participants in the Technology Utilization program is a greeting card manufacturer, this category, SIC 2771, was included for intensive sampling. No response was forthcoming, although the proportionate sample response indicated interest over broad areas of the industry (Printing, Publishing and Allied Industries.) The response was, however, below average.

An analysis of the response rate from each industry in comparison to the average response rate for the sample revealed some rather interesting facts, some of which have been alluded to in the preceding discussion. An example is the broad interest in Textile Mill Products (SIC 22XX). This seems to represent a declining industry fighting to survive through long over due technological improvement. Our contacts with Lowell Research Institute, which is dealing with this industry's problems, seem to bear out the survey results. To wit -- textile management is waking to the imminent danger of extinction and is eager to try to work with resources of technology. The high response of the paper mills in SIC 26XX, nearly double the average, reflects a good prospect for the utilization of the NASA resource in this activity. An analysis ofthis category's characteristics in Exhibit I of Appendix F reveals an average employee size of mearly 1300, an average number of technologists employed of 19 and an average technologist/employee ratio of 17.9%. There is nearly an equal reliance on the various modes of obtaining externally derived technological knowledge. The reporting units responding appears to be evenly divided into two groups. Those that maintain broad product lines and those that are narrow gauge productwise.

Although responses in 28xx--Chemicals and Allied Products--occurred in 6 out of the 8 three digit categories, the highest response came in two principal areas: 2821--"plastic materials, synthetic resins and nonvulcanizable elastomers"--and 2851, "paints, varnishes, lacquers, and enamels." These two categories contributed 16 of the 24 responses realized in the selected sample. A study of Exhibit I reveals for SIC 2821, a high average technologist/employee (T/E) ratio of 22.1%, a strong reliance on company libraries for information, and a tendency toward narrow product lines. Twenty-five percent of the firms reporting were dissatisfied with their sources of technical information.

SIC category, 2851, while having fewer average technologists than the firms in 2821, 4 versus 10, had a higher T/E ratio of 31% and over eighty percent of the firms were engaged at least part of the time in job shop activities as contrasted to continuous production processes. Nearly 30% of the companies were dissatisfied with their information sources.

The Leather and Leather Products (SIC 31XX) group was noticeable by its considerably below average response rate in both samples. In absolute numbers the greatest responses occurred in SICs 3111 and 3141, each with 6 replies. Actually SIC 3111 "tanning and finishing" has the highest T/E ratio of the group, some 11%. This ratio rapidly falls off to practically zero with the other reporting units. A check of the total group in Exhibit IV indicates that the T/E ratio is less than 5% while the number of technologists average two. The firms interviewed in this group expressed varying degrees of interest in the formation and utilization of an RDC. The most technically advanced in terms of technologist employment and T/E ratio was interested in the scientific and technical information available. The other firms were more interested in product development and management science workshops. Financing appeared to be a problem. This is probably endemic with industries known to be declining. Loan officers are chary of placing money in what "everyone" considers to be a dying industry. It is hypothesized that the weak response from this industry is a reflection of the comparative lack of technical sophistication. Once the resource was described by our interviewers to the top management of those firms, they became interested in participating, at least on some scale.

Like the textile industry in New England, the Primary Metals Industries (SIC 33xx) are declining regionally. The considerably above average response appears to reflect these industries' new awareness that they are engaged in a fight for survival. Five interviews were made in this general category and in general bore out the facts that the primary metals industries need assistance. Unfortunately, from an ease of technology transfer standpoint, this group tends to exhibit very low T/E ratios, less than 3%, and predominately derive their information from miscellaneous sources such as vendors, customers and suppliers (see Exhibit IV for statistical data on the entire 33xx group. The 4 digit summaries of Exhibit I are not too useful here.)

Finally SIC 38xx--Professional, Scientific and Controlling Instruments--provide the greatest response of all, approximately double the average response for New England industry--both selected and proportionate. Interestingly, the primary group may be divided into two distinct groups. SICs 3811, 3821, and 3831 all have high T/E ratios (45%, 29%, and 16%, respectively), and a high percent of their net sales to government (again 37.5%, 32.9%, and 22.5%, respectively). These groups comprise the non-surgical instruments manufacturers. The other portion of the group responding were the surgical instrument and photographic equipment manufacturers, namely SICs 3841, 3842, 3843, and 3861. These groups had T/E ratios near the 2% level sales to government ranging from 0 to 7.5%.

The statistics described above have been derived in the following manner and the detailed analysis may be found in Appendix F. The variables that have been included in the analysis are the average number and range of employees, the average and range of the technologist to employee ratio. Information on the type of sources used by the firms for acquiring technological information is listed by percent. The extent of product diversification has been imputed by observing the number of secondary SIC codes and their dispersion i.e., whether additional classifications are within the primary industry (2 digit code) or extend to other 2 digit codes. In the former case, a firm is considered to have a broad product base; in the latter case, the firm is considered to have a broad range within product lines. In some instances, a firm may have both broad interindustry and intraindustry product lines. This is coded in the exhibits under 3. A reporting unit not displaying any of these characteristics was listed under 4 with the implication that its product interests tend to be narrow.

Process flexibility is shown in the exhibits where 1 represents a company that is dominently involved in job shop activities. The figure 2 heads the column that corresponds to the percentage of firms engaged in continuous production or processes. The hybrid circumstance is listed under 3.

A column is included that illustrates the percentage of net sales under government contract. Although subject to interpretation, e.g., do second or third tier subcontractors consider their sales to a prime government contractor to fall in this category? Interviews with respondants indicates that most of the response to this question was interpreted as direct sales to the government.

The last bit of data included in the exhibits in Appendix F is the percent of respondants indicating satisfaction with their present sources of technical information.

Table 9 lists the technical fields of interest in each of the 150 selected SIC categories. To develop the table each incidence of interest was cumulated under the major heading and the total number of indications in each SIC category was then divided into the sum in each field. This resulted in the percent of interest in each major field. The fields with the highest percent of interest were then listed in descending order. The nearly universal interest in 120 "Industrial Processes" demonstrates a need for providing this type of information at the RDC operating level through such devices as standard interest profiles. For the management of the Technology Utilization program, it serves to focus attention on a prime area for acquisition activities.

Exhibit I of Appendix F deals with the statistics on the characteristics described above as they relate to the 150 individual SIC categories selected for high potential participation in the Technology Utilization program. As would be expected

Table 9

Fields of Interest
Ranked in Order of Importance

SIC Code	1st Rank	(%)	2nd Rank	(%)	3rd Rank	(%)	4th Rank	(%)	5th Rank	(%)
1951										
2086	70	60.0	150	20.0	160	20.0				
2231	70	45.5	150	18.2	60	18.2	90	9.1	120	9.0
2241	170	38.4	100	15.4	120	7.6	150	7.6	70	7.6
2311										
2394										
2421	170	26.8	150	19.9	70	19.9	90	6.6	100	6.6
2431	120	18.2	170	18.2	180	18.2	70	9.0	100	9.0
2441	170	40.0	150	20.0	70	20.0	100	10.0	120	10.0
2499	170	36.4	120	18.2	60	9.0	70	9.0	150	9.0
2512	170	100.0								
2621	170	37.8	180	18.6	70	12.6	60	6.2	30	6.2
2771										
2821	180	25.0	170	15.0	120	15.0	60	15.0	70	10.0
2834	60	49.8	50	16.6	100	16.6	180	16.6		
2841	160	60.0	70	20.0	60	20.0				
2842	60	66.6	170	33.3						
2851	170	37.2	180	24.8	60	12.6	70	12.6	160	6.3
2911	180	100.0								
2992										
3069	150	24.0	180	24.0	170	16.0	120	8.0	160	8.0
3079	180	20.7	120	16.9	150	14.3	170	10.4	100	7.8
3111	100	18.2	120	18.2	150	18.2	170	18.2	90	9.0
3131	180	30.0	170	20.0	150	10.0	100	10.0	70	10.0
3141	70	42.6	180	28.4	150	14.2	170	14.2		
3251	170	100.0								
3264										
3272	170	42.6	40	14.2	70	14.2	150	14.2	180	14.2
3291	150	40.0	130	20.0	20	10.0	70	10.0	170	10.0
3313										
3341	120	60.0	160	40.0						
3357	160	50.0	140	25.0	110	25.0				
3361	120	66.4	150	16.6	160	16.6				
3362	120	28.4	160	28.4	150	14.2	60	14.2	400	14.2
3391	120	20.0	140	20.0	150	20.0	160	20.0	170	20.0
3423	120	32.9	150	18.8	160	14.4	100	9.6	70	4.9
3429	120	40.0	150	30.0	30	10.0	70	10.0	130	10.0
3441	120	40.0	70	20.0	150	20.0	160	20.0		
3442	100	40.0	70	20.0	120	20.0	150	20.0		
3449										
3451	120	30.6	150	20.4	140	14.0	100	10.5	90	7.0
3452	150	20.8	140	15.6	120	15.6	100	15.6	90	15.6
3461	120	25.9	70	18.5	150	11.1	160	11.1	90	11.1
3471	120	22.5	60	15.0	70	12.5	150	7.8	160	7.8
3479	120	30.0	170	30.0	130	10.0	140	10.0	180	10.0

Fields of Interest
Ranked in Order of Importance
(Continued)

SIC Code	1st Rank	(%)	2nd Rank	(%)	3rd Rank	(%)	4th Rank	(%)	5th Rank	(%)
3481	120	30.0	160	15.4	100	11.5	90	9.2	140	9.2
3494										
3499	100	25.0	120	25.0	150	25.0	70	12.5	170	12.5
3511										
3519										
3522										
3531										
3532										
3533										
3534										
3535										
3536										
3537	70	33.3	150	33.3	230	33.3				
3541	120	22.8	150	22.8	160	22.8	230	15.4	170	7.7
3542	150	50.0	140	20.0	120	20.0	180	10.0		
3544	120	39.0	150	24.9	160	9.4	230	4.7	100	3.1
3545	120	49.6	150	24.8	140	6.2	100	6.2	90	6.2
3548										
3551	120	35.5	150	35.5	160	7.2	170	7.2	180	7.2
3552	170	37.5	150	25.0	140	12.5	110	12.5	60	12.5
3553										
3554	100	40.0	40	20.0	150	20.0	170	20.0		
3555	180	60.0	170	20.0	60	20.0				
3559	150	15.6	230	15.6	180	10.4	120	10.4	100	10.4
3561	150	33.2	160	16.6	120	16.6	100	16.6	30	16.6
3562	30	25.0	140	25.0	150	25.0	160	25.0		
3564	230	40.0	180	20.0	120	20.0	70	20.0		
3565										
3566	100	40.0	120	20.0	150	20.0	140	20.0		
3567	180	20.0	120	20.0	230	20.0	140	20.0	160	20.0
3569	140	42.6	150	28.6	180	14.3	160	14.3		
3571										
3572										
3576	100	40.0	140	20.0	150	20.0	90	20.0		
3579	90	60.0	140	20.0	400	20.0				
3581										
3582										
3585	120	30.0	90	10.0	70	10.0	160	10.0	230	10.0
3586										
3589	120	60.0	160	20.0	170	10.0	150	10.0		
3591	120	28.1	150	17.2	70	12.5	190	4.7	170	3.1
3599										
3611	90	33.2	100	33.2	140	16.6	120	8.3	110	8.3
3612	100	80.0	120	20.0						
3613	100	30.0	120	20.0	140	20.0	180	10.0	110	10.0
3619										
3621										

Fields of Interest
Ranked in Order of Importance
(Continued)

SIC Code	1st Rank	(%)	2nd Rank	(%)	3rd Rank	(%)	4th Rank	(%)	5th Rank	(%)
3622	100	36.0	120	27.0	140	27.0	150	9.0		
3623										
3624										
3629										
3631										
3632										
3633										
3634										
3635										
3636										
3639	60	20.0	90	20.0	70	20.0	30	20.0	160	20.0
3641										
3642	120	66.6	100	33.3						
3643	100	19.8	120	19.8	160	13.2	180	13.2	90	13.2
3644										
3651										
3652										
3661										
3662	90	57.2	100	20.8	230	10.4	140	5.2	170	5.2
3671										
3672										
3673										
3679	90	35.0	100	15.0	140	12.5	170	10.0	230	7.5
3691	70	60.0	30	40.0						
3692	90	20.0	50	20.0	140	20.0	100	20.0	150	20.0
3693										
3694										
3699	90	17.5	150	14.0	100	10.5	120	10.5	130	7.0
3711										
3712										
3713										
3714	120	33.3	150	33.3	110	11.1	70	11.1	180	11.1
3715										
3721										
3722										
3723										
3729	120	37.5	100	12.5	140	12.5	10	12.5	30	12.5
3731										
3732										
3741										
3742										
3751										
3791										
3799										

Fields of Interest
Ranked in Order of Importance
(Continued)

SIC Code	1st Rank	(%)	2nd Rank	(%)	3rd Rank	(%)	4th Rank	(%)	5th Rank	(%)
3811	140	35.5	120	14.2	160	14.2	130	7.2	100	7.2
3821	140	35.0	90	10.5	130	7.0	110	7.0	100	7.0
3822										
3831	140	60.0	130	20.0	230	20.0				
3841	120	40.0	140	20.0	130	20.0	150	20.0		
3842	180	33.2	70	16.6	170	16.6	150	8.3	400	8.3
3843	160	40.0	170	20.0	90	20.0	60	20.0		
3851										
3861	130	50.0	60	50.0						
3871										
3911	120	50.0	150	15.0	90	15.0	170	10.0	60	5.0

there is considerable variance between SIC categories on the different characteristics sampled. Themajor drawback to this analysis is the small number of responses that occur in many of the categories. The low number prevents making statistical inferences with any degree of confidence on many of the categories sampled. To overcome the disadvantage of the loss of statistical significance in estimating the parameters of the variables in each four digit SIC category, we have aggregated the data on a two digit basis. The results ofthis analysis are displayed in Exhibit II. The information loss resulting from the aggregation is also significant as the four digit code may be thought of as essentially a product group, whereas the two digit code tends to reflect an industry.

For comparative purposes we have analyzed the same two digit categories using the proportionate, random sample of 10% of the entire New England industrial population. The results are shown in Exhibit III.

The first three analyses are defensible from a statistical sampling standpoint. All were obtained using samples of the individual four digit classifications that were in the same proportion as the total population in the category was to the total industrial population in New England. Inferences drawn about comparative response rates have a statistically sound basis. On the other hand, a large part of our analysis of New England industry is not necessarily concerned with interclassification comparisons, but rather with the effect of the firms' various technology or corporate characteristics on the Technology Utilization program. In this case the major concern of the analysis is with the total information available on reporting units in the area regardless of their particular SIC code. To this end, we have made several analyses using all the combined information available. The first of these, in Exhibit IV, illustrates the effect of combining all information on an aggregated two digit SIC code basis. For interest, this exhibit may be compared to Exhibits II and III described previously.

For interests sake, the basic data has been further analyzed in the following ways not previously discussed.

Exhibit Number	Methods of Sorting
V	Eight categories--described in section I.3.2 below.
VI	Eleven cells based on Technologist/ Employee Ratio
VII	Twenty cells based in Technologist/ Employee Ratio
VIII	Information sources
IX	Product Diversification
X	Process Flexibility
XI	% Government sales (11 cells)
XII	Four digit SIC-reporting units interviewed
XIII	Eight Categories-reporting units interviewed
XIV	Total sample - no sorting

I.B.2 Determining the Specific Needs for Technology in New England

Prior to making the detailed analysis of New England industry, we developed a hypothesis to test. This hypothesis was structured in the form of a decision tree that resulted in eight categories of firms that would have different needs for technology and therefore might need different kinds of service from a regional dissemination center in order to satisfy the postulated diverse needs. The criteria for generating these eight categories of firms is as follows:

1) Does the firm employ technologists?

   Our questionnaire implicitly defined technologists by asking this question, "How many technologists (employees with college degrees, or equivalent, in engineering or the sciences) do you employ in the following areas:

   Basic or Applied Research?

   Product Improvement?

   Development Engineering?

   Production Engineering?

   Other?"

2) Does the firm have 100 or more employees?

Given technologist employment, the following questions were asked:

3) Does the firm engage in basic or applied research?

4) If not research, does the firm engage in product

<u>improvement or development engineering activities?</u>

5) <u>None of the above</u>

These criteria result in the following structure and end categories.

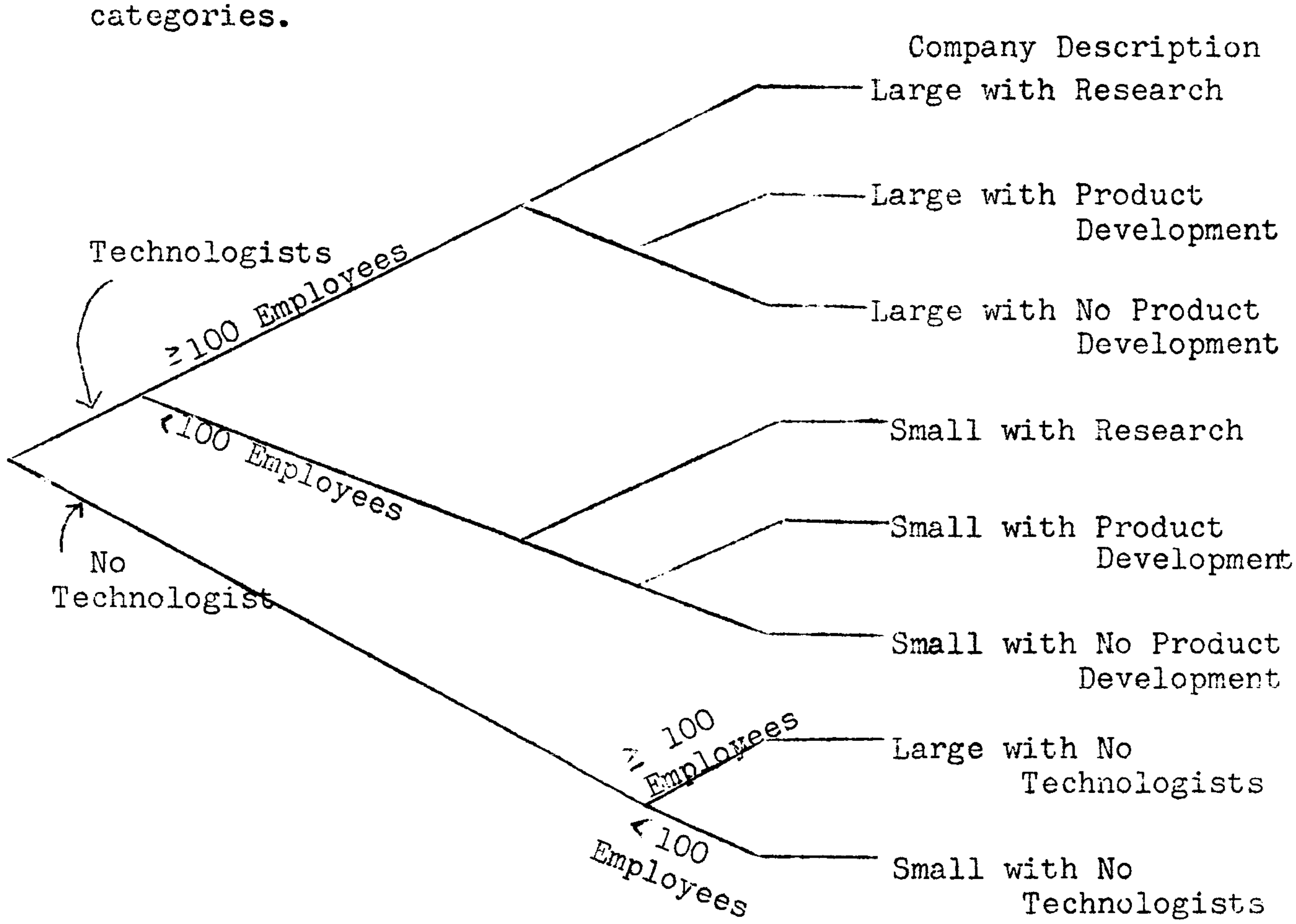


Figure I.B. - 1

The reasoning for this breakdown are self-evident when you consider the technological resources available through the NASA Technology Utilization program. Obviously whether or not technologists are on the payroll will influence a company's motivation for, and utilization of, externally derived knowledge. This is not to say that the absence of technologists negates the possibility of the firm's participation in the program. The nature of such participation is certainly affected. The question of size of the participating company is important because of the very different nature of the *modus operandi* of the management of different sized firms. Shorter communication lines, faster decision-making, and a higher degree of entrepreneurialship tend to be an inverse function of the size of the company. Obviously all these factors may have an impact on a firm's use of externally derived technology.

Lastly, the nature of the technological activities being engaged in a firm were postulated to affect the needs of the company for precise utilization and "purchasing" of the resources.

Given this hypothesis, we structured our data gathering and analysis in such a way to verify, modify or reject the postulate. As mentioned above, the data accumulated via the questionnaire contained all the information necessary for categorizing responding firms according to the hypothetical structure described. To provide a means for testing the hypothesis, we interviewed 95 firms in the region. These firms were selected to be representative of the principal industrial classifications in New England as well as for covering the eight categories involved in the hypothesis. The actual selection of the individual companies was essentially random except for their geographic distribution, which we tried to make proportionate to the concentrations existing in New England.

A team of 13 interviewers were trained and sent into the field to meet with top executives in the selected companies. An interviewer's list of questions was prepared based on the following strategy (see Appendix A, Exhibit 4). First, the interviewer attempted to get the executive to define how he uses technology in his business and what his company's needs for technology were. Next, the interviewer explained the technological resources of NASA and the typical RDC in conceptual terms, attempting to avoid references to specific service packages. Then, having gotten the executive to describe his needs and having explained a resource that potentially could satisfy some of these needs, the interviewer asks how could the executive's company best utilize this resource. From this point the interview was extended into specific areas and issues relating to technology transfer, services, and possible problems that a manager might foresee in a relationship with an RDC.

In Appendix A, Exhibit V identifies the SIC categories of firms interviewed, the number of firms interviewed in each category, and a description of the category. Exhibit XII, of Appendix F, provides statistics on the characteristics described in section I.B.1 with the data summarized by 4 digit SIC code. In Exhibit XIII the sameinformation is sorted into the eight categories hypothesized earlier in this section. These statistics provide the basis for comparative analysis to the larger sample of New England firms upon which extensive data has been collected.

For example, Exhibit V contains statistics on all thé firms surveyed and divided into the eight basic categories.

The results of the interviews are summarized as follows in terms of the hypothetical structure. The structure appears to collapse from eight to five or possibly six distinctive categories of firms with different needs for technology.

The large (100 or more employees) firms engaged in basic and applied research are interested in utilizing the NASA resource for state of the art research, for insurance against missing some obscure work done in the government or overseas, for obtaining government material in a reasonable length of time, and the possibility of discovering some interdisciplinary transfer from a field not normally reviewed. Some large research and development oriented firms regard the regional dissemination centers as potential intruments in the dispersion of innovations and research created in-house. These organizations thereby provide the input side to user-producer conferences. Speed of operations does not appear critical to the typical large firm with or without technical capability.

Small firms (under 100 employees) engaged in basic or applied research create a different situation than that which was observed in the larger firm. This type of firm appears to require the same kind of technology in terms of sophistication as does the larger firm. The principal difference is that it needs it faster to meet its shorter planning horrizon and contract proposal deadlines. Two day to one week turn around times are required in this environment. There is probably less concern with continuing cognizance in an area than there is with the larger R & D firm. Again, this is a function of the short planning horizon. Diversification is a problem that may promote the requirement for longer term committments to an RDC. To broaden the typically narrow technical and product base, these firms would be excellent output sinks in a user-producer conference.

Large firms with or without product improvement or development engineers appear to fit together. Although perhaps not as technically sophisticated as the category of firm's discussed above, these companies have competent engineers engaged in creative application work. In some instances knowledge of a research nature would be appropriate on an ongoing basis. Innovations for product and process improvement are desirable to maintain large production. A major difference between the large and small non-research, technical firms is the emphasis in the small firm toward job shop work while the tendency in the larger plant is toward continuous production. Effect of this on technology transfer is rather serious. There is built in inertia in the case of production lines. Typically, continuous process production involves higher capital investment, special purpose machines and a natural tendency to resist change, which could only raise costs and lower production in the short run. In contrast, the job shop is organized to cope with change through the use of general purpose machines, high in-process inventory and highly flexible conveying equipment e.g., fork lift trucks versus a conveyer belt in a continuous product setup. Indications are that the management of this type of firm is interested in management science techniques and workshops.

Small firms utilizing technologists but not engaged in research, present a somewhat different problem than the similar large firm. The principal differences appear to be speed of response to demands on the system, a more entrepreneurial management, a tendency toward job shop operations, and a technologist/employee ratio that averages 25%, over four times as large as that exhibited by the large firms in the same category. These factors make for a much more exciting environment and one in which innovations are more likely to be developed and implemented. The average technical sophistication of the company is deeper than their larger brother and their requirements for technology are correspondingly more demanding.

The final category defined by our interviews involves the firms that do not employ any technologists. The possibility suggests itself that we should divide these firms into large and small. Although their needs are vertually identical, indications are that dealing with the two groups would be quite different. The larger firms tend to see no need for technological inputs to their system. Some have expressed interest in management science workshops. The general tendency is resistance.

The smaller firms reacted two ways. One, management felt it was too small, too poor, too busy to bother with the technology resource. Others could see the value but lacked the staff to interpret and implement material relevant to their problem--they were interested. Surprisingly, to the project team, more of the small companies interviewed were actively interested than were not. This group was also interested in management science workshops although not to the same extent that the larger firms were.

I.C. BIO-MEDICAL APPLICATIONS

The approach to determining the feasibility and value of an RDC's services to the research hospitals in the region has been based on the following rationale. During visits to the RDCs at Wayne State, Indiana and Pittsburgh the question was asked: What success have you achieved in servicing hospitals and medical researchers? The answer was--very little success. Presentations where they were directed to medical professional groups, were warmly received but nothing had come of the efforts in terms of contractual relationships with medical research groups. The next question was: Why did you fail? The answer was -- we are not really sure what the problem is. Consequently, in approaching the problem in New England it was felt that it was important to develop an understanding of what the inhibiting forces were to bio-medical applications and to the use of externally derived knowledge by medical groups.

It has been on this basis then that the problem has been attacked. The initial concern has been in attempting to identify barriers to the use of an RDC's resources. Inasmuch as ltttle was apparently known about these barriers an empirical approach has been taken by attempting to introduce externally derived knowledge into a medical research group and observing the effects of this action.

Seven medical information retrieval questions were sent in by the Research Staff Coordinator at the Boston University Medical School. First, a hand search on each question was performed, using the Aerospace Medicine and Biology Continuing

Bibliography (NASA SP-7011 series.) Second, machine retrieval questions were formulated and used as test questions during the computer retrieval production testing stage. It should be noted that the searches were performed at NERAC and that only the abstracts required were then obtained from ARAC. The results of both searches were sent to the respective doctors for study and evaluation. Shortly thereafter, face-to-face individual discussions were held between the doctors and a center staff member for evaluating results and machine retrieval question restructuring. These revised questions were used in our computer timing run. It is too early to evaluate the final results, but it is of considerable importance to note that one of the medical questions could only be performed on the computer. This was because all appropriate retrieval concepts were all in machine index terms and not in published index terms. A meeting with all participants in the study was held early in December to evaluate the experimental program and to determine what modifications or different approaches may be required to service the medical research community adequately.

The result of this meeting may be summarized as follows. There seems to be no technological "barrier" to the effective use of the NASA file for biomedical applications. Aside from the importance of maximum depth of indexing (which means a computer search is mandatory), no unusual problems were encountered during the experiment. Discussions, of what the apparent barrier to widespread medical use might be, centered on the structure of medical research organizations.

Typically, research is carried out on a highly autonomous basis by the principal investigator. Funds for prolonged searching as typified by the monthly selective dissemination genre of search must normally be included in the budget in advance of use. The long lead time mitigates against this. Also, knowledge of the value of monthly searches must be learned but there is no convenient mechanism for this except through commitment of resources out of the investigator's future budget.

Discussions with the Yale medical group were also held in a further effort to explore the apparent barriers to participation in RDC programs. Discussions with medical researchers, the Librarian and administrators at the Yale Medical Center has resulted in the development of a model for obtaining effective distribution of NASA bio-medical information. It appears that the primary focus of interest in medical centers is the Medical Library. Medical researchers consistently follow the practice of requesting literature searches of the Medical Library, and Librarians are extremely anxious to respond to these requests in a rapid and exhaustive manner. Therefore, Librarians are interested in the NASA information because they believe it will supplement existing resources and the information can be quickly obtained. Of course, the continued use of the NASA service will depend upon the utility of the information to members of the Medical Center.

From a marketing point of view, solicitation of the Medical Librarians has several advantages. First, the primary mission of the office of information with all of its ramifications;

secondly, budgets in the library always include funds for literature searches; thirdly, contracts for services can be negotiated with one office rather than possibly with several researchers or departments; and findally, missionary work stimulating the use of NASA information can be effected interaally because it seems to enhance the value of the medical library.

This approach ties in with the conclusions of the conference with members of the Boston University Hospital staff. It is our recommendation that further study in this area be financed separately and that it should be done by a team with credentials in the bio-medical disciplines at least in the exploratory phases. The latter suggestion is based on considerable experience with medical personnel that has demonstrated medical credentials are requisite to gain the full rapport with medical researchers that is needed in the experimental phases of a program like this.

UNIVERSITY RESOURCES AND INDUSTRIAL SUPPORT FOR PROPOSED REGIONAL DISSEMINATION CENTER

II.A. Description of University of Connecticut

The University of Connecticut would provide a strong resource base for establishment of a regional dissemination center. Geographically the University is located at the center of a circle with a 90 mile radius that encompasses the industrial complex in Massachusetts, southern New Hampshire and Vermont, Rhode Island and Connecticut, the principal concentrations, of course, located in the Greater Boston area and in southwest Connecticut from New Haven to Stamford. Within a fifty mile radius of the University are the important secondary industrial concentrations at Worcester and Springfield, Mass., essentially all of Rhode Island including Providence, and the Greater Hartford area. Ready access to all of these areas is provided by an excellent system of freeways and toll roads.

Academically the University provides a strong base for support in the many professional schools and institutes. The School of Engineering, for example, has a graduate program leading to the Ph. D. in the Department of Aerospace Engineering. Other strong departments in the School include Electrical Engineering, Chemical Engineering and Mechanical Engineering. A Department of Metallurgy has been authorized and is being staffed at the present time. Equally strong departments in the College of Liberal Arts and Sciences include Physics, Chemistry and Mathematics. The Institutes of Materials Science and Pharmacy Research provide additional interdisciplinary strengths in the understanding and utilization of new technology. Support for a regional dissemination center is assured from these schools and institutes as evidenced by the fact that the Dean of Engineering, Pharmacy and Business Administration and the Director of the Materials Science Institute are all members of the New England Research Application Center Advisory Board.

Further support would be forthcoming from the Wilber L. Cross Library which houses some 750,000 volumes plus extensive microfilm holdings. The library's director also serves on the Advisory Board. The school divisions and institutes that comprise the University are listed below:

SCHOOLS AND COLLEGES

The College of Agriculture
The School of Business Administration
The School of Dental Medicine
The School of Education
The School of Engineering
The School of Fine Arts
The Graduate School
   The Research Foundation
The School of Home Economics
The School of Insurance
The School of Law
The College of Liberal Arts and Sciences
The School of Medicine
The School of Nursing
The School of Pharmacy
The School of Physical Education
The School of Physical Therapy
The Ratcliffe Hicks School of Agriculture
The School of Social Work

DIVISIONS

Continuing Education Services
   Labor Education Center
   Institute of Public Service
National Defense Training
Intercollegiate Athletics
Libraries
Health Service
Student Personnel

INSTITUTES

Institute of Cellular Biology
Marine Research Laboratory
Institute of Nutrition and Food Science
Institute of Materials Science
Pharmacy Research Institute
Institute of Urban Research
Institute of Water Resources

The current enrollment in the University stands at 16,000 including some 3700 graduate students. In addition to the main campus at Storrs, branches are operated in Hartford, Waterbury, Stamford and Torrington, as well as professional schools of law, medicine, insurance and social work in Hartford. A new site at Groton will open this year which will include marine research facilities.

As a Land Grant College the University has always taken the posture of serving the needs of Connecticut. It maintains close ties to the business community and is concerned with the application of knowledge to the solution of problems occurring in society. Formal recognition of these objectives is demonstrated by the support of its institutes and specialized centers, and the many conferences held each year, but the objectives of community service are also realized by the many informal relationships that members of the faculty have with the public and industrial community in Connecticut and the rest of New England.

The University is actively participating in educational programs as part of the State Technical Services Act of 1965. Close ties exist with the Connecticut Research Commission which administers the Act, as well as funding other research. The Connecticut Development Commission is supporting the University's effort to establish a Regional Dissemination Center by providing the services of two development technologists to assist in the project.

II.B. New England Research Application Center

Organization and Staff

NERAC is an organizational unit of the University recognized by the Board of Trustees and supported in part by University funds. The extent of this support under the proposed RDC operation will be detailed in the section covering the proposed annual budget for the RDC. If an RDC is established at the University of Connecticut as recommended, NERAC's primary responsibility would be the operation of such a center.

The initial organizational configuration that would be used in meeting the needs of New England industry for technology is diagramed in Exhibit 2. Members of the Advisory Board include prominent representatives from the academic community in New England as well as highly respected and influential leaders from business, research hospitals and state agencies all of which are intensely concerned with the transfer of technology in New England. The names of those serving on the board are listed below along with their affiliation:

Chairman: Dr. Robert O. Harvey	Dean, School of Business Administration, University of Connecticut
Secretary: Mr. S. William Yost	Project Director NASA Feasibility Study University of Connecticut
Dr. Leonid V. Azaroff	Director, Materials Research Institute, University of Connecticut
Dr. Arthur B. Bronwell	Dean, School of Engineering University of Connecticut
Dr. John S. Burlew	Director, Connecticut Research Commission
Dr. Robert Fetter	Professor, Industrial Administration, Yale University
Mr. Robert S. Goodyear	President, Smaller Business Association of New England and President, Fenwall Electronics

Dr. H. G. Hewitt	Dean, School of Pharmacy University of Connecticut
Mr. Leroy Jones	Managing Director, Connecticut Development Commission
Mr. John P. McDonald	Director, Wilbur Cross Library University of Connecticut
Mr. Sumner Meyers	National Planning Association Washington, D. C.
Mr. Erwin Pietz	President, Associated Industries of Massachusetts and President, Barry Wright Corporation
Dr. Edward B. Roberts	Associate Professor, Sloan School of Management Massachusetts Institute of Technology
Dr. Richard S. Rosenbloom	Associate Professor, Graduate School of Business Administration, Harvard University
Dr. Albert W. Snoke	Executive Director, Yale-New Haven Hospital
Mr. Frederick H. Waterhouse	Executive Vice-President, The Manufacturers Association of Connecticut

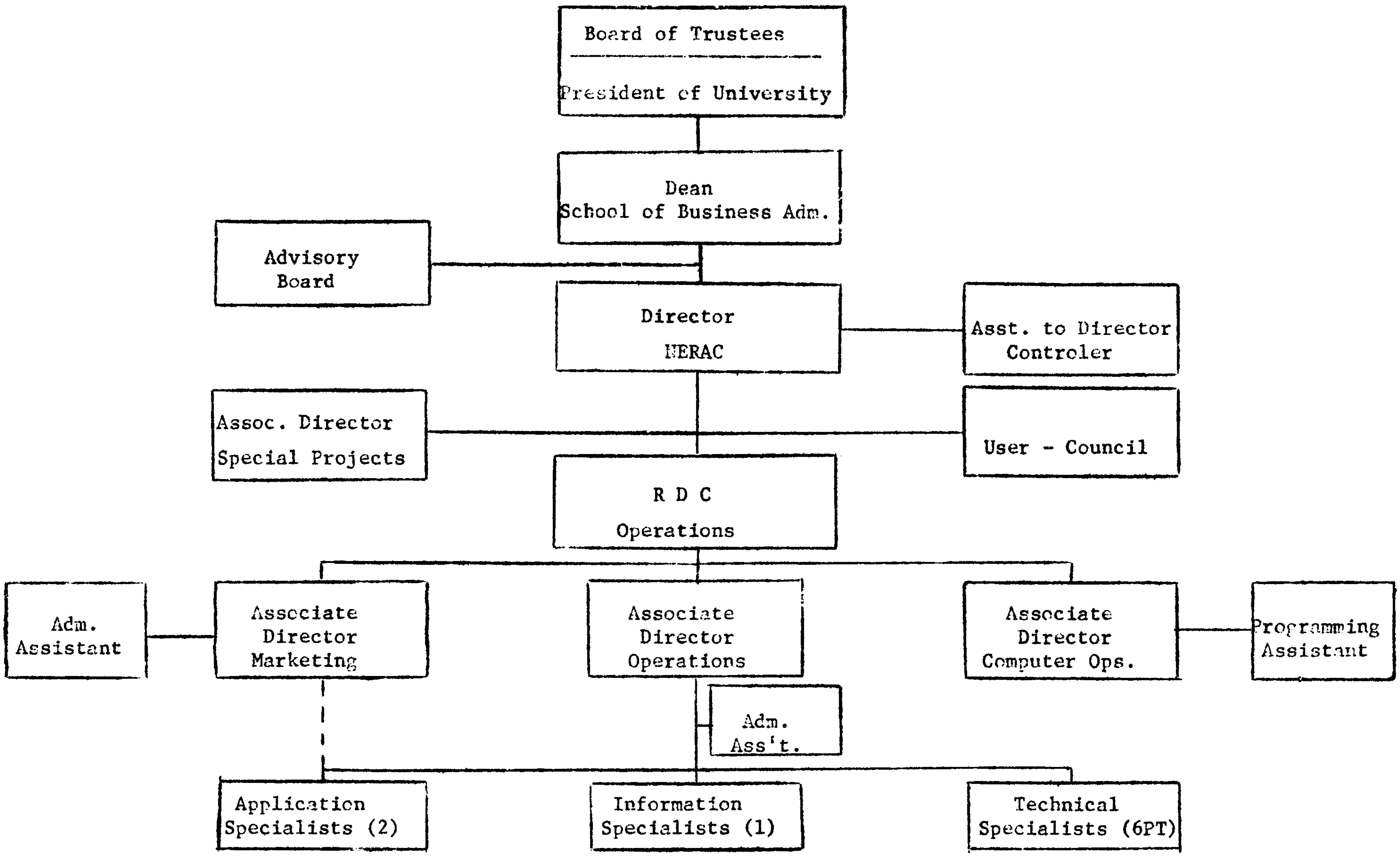
The membership of the board is strongly academic with representatives from the outstanding universities in New England as well as from the University of Connecticut. The high proportion of scholars reflects the Center's commitment to activities that will lead to a more precise understanding of the process of technology transfer. Several of the members of the Board are eminent researchers in this subject. In addition these people demonstrate the degree of support for the Center's activities in New England's leading universities.

Upon the establishment of an RDC at Connecticut a Users Council will be formed from those people who are actually using the Center's service. This group will serve as a pragmatic forum which will counter balance the scholarly inquiry promulgated by the Advisory Board. The User Council will deal with questions of operating policies and plans in an attempt to make the Center more effective in responding to users needs. Representatives from all Center clients will be eligible to participate in Council meetings which would be held at least once a year.

An analogy may be drawn from business to explain the relationship of the two advisory groups to the Center. The Advisory Board may be thought of as comparable to a corporate board of directors, while the Users Council may be considered loosely equivalent to a stockholders meeting.

The Director of NERAC is responsible for the successful operation of the Center subject to the policy guidelines established by the University and the Dean of the School of Business Administration. He draws upon the advice of the Advisory Committee in setting goals and objectives for the Center and reviews plans for meeting these goals with the Board.

Assistant to the Director - Controller is responsible for budget planning and control, purchasing, travel authorization, office and personnel records and general administration and coordination including the final preparation of reports.



Board of Trustees
President of University
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Director
NERAC
Asst. to Director
Controler
Assoc. Director
Special Projects
User - Council
R D C
Operations
Adm.
Assistant
Associate
Director
Marketing
Associate
Director
Operations
Associate
Director
Computer Ops.
Programming
Assistant
Adm.
Ass't.
Application
Specialists (2)
Information
Specialists (1)
Technical
Specialists (6PT)

Associate Director - Special Projects has the responsibility for the management of special projects, i.e., projects that are not part of the RDC's normal operations. This organization permits close attention to important non-operating functions and facilitates cost accounting.

Associate Director - Marketing is responsible for promoting new business and maintaining current business. Activities would include participation in area industrial and related conferences, personal contact with clients and potential clients, organization of user-producer conferences, management workshops and other activities that enhance the image and effectiveness of the Center in transferring technology. He will work closely with the application specialists on these activities as part of the applications specialist's job relates directly to marketing and these functions will be subject to the Marketing Director's direction.

Associate Director - Operations is responsible for the RDC's operations with the exception of the computer operations. These responsibilities include the provision of technical skills for the identification of user problems and questions, the refinement and search strategy development, evaluation of search results and communication with the user's recipients of technical information. Further he shall provide the application services and personnel described in a later section of this report. All inhouse processing of requests, documentation, and reproduction shall be within his province. He will work closely with the Marketing and Computer Directors to relay the feedback from the user in order to maintain high quality timely service.

Associate Director - Computer Operations is responsible for all data processing activities including file searches, cost accounting, user profile analysis research, operations simulation, keypunching and the maintenance of file records. He will be responsible, along with the Operations Director for reducing as many clerical and typing activities to machine operation as possible where the economics are favorable, of course. In addition to cost reduction programming, he will be responsible for keeping abreast of information retrieval technology and for initiating research into the process when possible applications or studies suggest themselves.

II.C. Evaluation of Industrial Support

Extensive efforts have been made to acquaint the New England industrial and academic communities as well as governmental agencies with the proposed program. These efforts have been primarily in the nature of face-to-face contacts although letters, brochures and questionnaries have also been used. (Copies of these may be found in Exhibits I, II and III.) The response to the total market testing program has been very favorable. As a market test of positive industrial support for an RDC in New England, a number of firms have been contacted and asked to sign Letters of Intent to contract for services should a center be established. Thus far thirty-nine companies have been called on and of these twenty-three have signed Letters of Intent (a list of those who have signed may be found in Exhibit IX). Another thirteen firms have promised to sign the Letter of Intent. A copy of a Letter of Intent is attached to this report as Exhibit X. In sum, then, thirty-five firms out of the thirty-nine contacted directly have shown positive support for the establishment of an RDC in New England. This is a support/contact ratio of approximately 90%, which appears to be remarkable judging from the experience of existing RDC's in acquiring client firms.

It is also interesting to note that of the companies supporting the proposed center over seventy percent are small or medium sized (less than 500 employees). The response from these firms tends to verify the conclusions drawn from the analysis of New England industry and the subsequent approach used in developing an operational concept that would serve the needs of the smaller, technically oriented firms as well as the other segments of industry identified.

A mail questionnaire, was sent to the 639 firms that have been previously identified as being prime candidates for the services of an RDC by virtue of their technological capability. The purpose of the mailing was threefold. One purpose was to test the assumption made in the above analysis that the firms, though small, exhibited a high degree of technical sophistication in their interests. The responses to Question One of the questionnaire, namely, "In which specific areas of technological research, advancement, and innovation would your firm be most interested," indicated a remarkable degree of sophistication and amply verified the assumption. (For typical examples of the response to this question see Exhibit IV.) Another purpose of the mailing was to identify a number of areas of technological interest which, in all probability, would provide the basis for establishing a number of Standard Profile searches. The final purpose of the mailing was to acquaint these prime client companies with the efforts of the project staff to determine the feasibility of establishing an RDC in New England.

The response to the questionnarie is believed to be significant for two reasons. One was the high percentage of response, which was over 27%. Another is the indication of interest in the Center that has been shown by the one in seven respondents who requests further information about the center. A breakdown of the responses is tabulated below:

		Column A Connecticut	Column B Massachusetts	Column C Total
1.	Letters and questionnaires mailed	224 (35.1%)*	415 (64.9)*	639
2.	Total response	73 (32.6%)**	104 (25.0%)***	177 (27.7%)*
3.	Returned questionnaires anonymously	64 (28.6%)**	88 (21.2%)***	152 (*$.*%)°°°
4.	Request for Info.	9 (12.3%)°	16 (15.4%)°	25 (15.2%)°°°

* Percent of line 1, column C
** Percent of line 1, column A
*** Percent of line 1, colume B
° Percent of line 2, column A
°° Percent of line 2, column B
°°° Percent of line 2, column C

The results of this questionnaire were invaluable to the process of devising service packages for this segment of the market. In the same light the technology profiles that the Small Business Administration has developed are being examined for clues to the Regions' areas of greatest specific technological interest.

Industrial Association Support

In addition to the personal, direct contacts with companies in New England and the mailing program already described, a considerable amount of effort has gone into determining the support available from the major industrial associations in the region. To this end, the project staff has made presentations, has exhibited and plans on publishing information about the project with many of the industrial associations serving New England.

The main thrust of the project's marketing operation in Massachusetts and Connecticut has been to acquaint industry with the Technology Utilization Program, generally, and specifically, with the regional dissemination centers' transfer. The response has been very favorable; virtually every major industrial and commercial journal has requested copy about Technology Utilization Program (TUP) and the study at Connecticut. The two leading industrial representatives in Massachusetts, Mr. Erwin Pietz, President of the Associated Industries of Massachusetts (AIM) and Mr. Robert Goodyear, President of the Smaller Business Association of New England (SBANE) have indicated their interest in corporate membership for their firms, should an RDC be established and have themselves agreed to serve on the Advisory Board.

In Connecticut, Mr. Fredrick Waterhouse, Executive Secretary of the influential Manufacturers Association of Connecticut, has agreed to serve on the Advisory Board and to publish an article on the proposed RDC in a special Association bulletin.

Dr. Arthur S. Obermayer, Chairman of the Research Management Association, an organization of small, research based Boston area companies, was contacted about the proposed program and a presentation was made at a meeting of the Association. As the result of these activities, the Association has endorsed the formation of an RDC in New England along the lines proposed in this report To quote from the letter of endorsement (which is attached as Exhibit VII of Appendix E.

> "We feel such a center would provide a valuable information source for the smaller research and development corporation. We would expect as an organization to provide requirements information to such a center and feedback, so that the RDC can be responsive to the needs of the smaller R & D company.
>
> "The type of operation described....would, as a first approximation, seem responsive to the needs of our member companies."

The strong positive response of these four industrial leaders is certainly significant in terms of industrial support for an RDC in New England. In addition, a very favorable working relationship has been established with the New England Council. The New England Council is one of the most effective forums for an RDC to acquaint New England with TUP and to provide feedback on a continuing basis on the changing requirements of the business community. The Council has been instrumental in having an article suggested for publication in The New Englander and has asked the center to participate in their annual meeting. Mr. Peach, the Chief Executive Staff Officer, and Mr. Healey, their Business and Industry/Industrial Development Specialist, have been working with the center to set up a seminar at Storrs to acquaint their membership with TUP. Tentative date for this seminar is the second week in February.

General Promotion

Five areas of promotion have been studied: a) Publication in local industrial magazines and news letters; b) TV and radio appearances; c) Exhibitions at industrial meetings and conventions; d) Presentations and participation at industrial/professional meetings and gatherings; and e) Feature article publications in other news media, both on and off the University campus.

Publication of articles defining the NASA Technology Program and specifically the approach proposed in this report for the New England industrial community is presently planned in the following industrial journals: The New Englander: This magazine covers the membership of the New England Council, the largest industry/business association in New England; magazine circulation is about 7,500. It is distributed to industrial and business leaders at no charge. The article was suggested by Mr. Peach, Chief Executive Staff Officer of the Council.

Industry, Special Aerospace Edition: This is the magazine of the Associated Industries of Massachusetts (AIM). The Association has over 2,300 members which includes virtually every industry in Massachusetts. The planned article will be co-featured with an article by Dr. Kelly of the Electronic Research Center covering the overall Technology Utilization Program. This edition of Industry will include a complete run-down of the AIM 51st. annual meeting , at which NERAC was invited to and did exhibit, thereby reinforcing the coverage and impact of the article.

Greater Boston Chamber of Commerce Industry Newsletter: Following a discussion with Thomas McGrath, Chief of the Chamber's Research and Development Department, Mr. McGrath requested that NERAC submit copy for inclusion in their Industry Newsletter. In addition he requested that we send him brochures and other TUP literature for distribution to interested members.

SBANE Bulletin: This article will detail the NERAC approach to the specific technology needs of the New England small businessman. Mr. Robert Goodyear, President of Fenwall Electronics Corporation and President of the Smaller Business Association of New England (SBANE) invited NERAC to submit an article.

Future plans in the area of publication include a continuing series of articles in The New Englander, Industry, and the Greater Boston Chamber of Commerce Industry Newsletter and the SBANE Bulletin. These follow-up articles will include the proposed center's activity reports, case histories of technology transfers, research reports sponsored by the proposed RDC seminar reports. In addition, these four leading industry news media will be used to announce seminars and other activities to which New England industry will be invited. Further, by working through the industrial news media, the proposed RDC will itself be apprised of industry interest in our activities, of new trends in technology transfers and of the changing needs of the community.

An indication of industrial support has been the fact that there was no need to request the opportunity to publish. The industrial news media in the Greater Boston area are apparently so aware of the potential benefits of a program such as the proposed center to their subscribers that they have in each case extended an invitation to publish an article detailing the operation. Contact is planned with the industrial journals of Maine, New Hampshire and Vermont, and articles tailored to the needs of these states will be submitted for publication in the near future.

Contact has been made with the Boston Education TV channel, WGBH, through Miss Elizabeth Straus, who is in charge of research for the Science Reporter. Present plans call for a detailed program discussion in December to define a New England Technology Utilization Program. We have made arrangements with the

University of Connecticut Radio-Television Center to assist in writing the script. Contact was also made with Mr. Myron Spencer of WGBH who handles the 10 p.m. news show, and it is hoped that a news feature describing this unique industry-university-government cooperative effort will be presented in the near future. In addition, plans are under way to contact the local radio stations to determine the interest in a program on new technologies and their dissemination. It appears that such a program stands a very good chance of acceptance in the Boston and Hartford areas due to the intense interest in new technologies. Such a program would include the proposed center's personnel with Harvard/M.I.T. faculty participating using a script prepared by the University of Connecticut Radio-Television Center. WHDH is a likely candidate, due to its varied program content and to Mr. Doctors' prior work with WHDH. WHRB is also a likely candidate, due to its emphasis on public affairs and science reporting. In general, promotional efforts in this area would hope to provide a continuing number of programs in the new technology area, thereby acquainting both the industrial community and the general public with the NASA program.

Through the very generous offer of Mr. Robert Chadbourne of AIM, NERAC had the opportunity to exhibit at the 51st. AIM Annual Meeting. Working with Mr. Philip Gilmore, Director of Research and Development for AIM, project personnel were able to put together an exhibit which attracted over fifty members in about 6 hours of actual time. The response was uniformly affirmative and enthusiastic. Every follow-up from the convention, thus far, has resulted in a potential new RDC client.

Due to their timing participation was not possible in the North East Research and Engineering Meeting (NEREM) and SBANE meetings. But it seems clear such gatherings provide an excellent forum to inform industry and the professions about TUP.

Future plans would include the designation of a staff member specifically responsible to provide timely contact with all such meetings in New England and to make such contacts and arrangements as are necessary. The industrial and/or professional meeting provides an excellent media for communication with large numbers of interested persons, thereby reinforcing the articles in the trade magazines and TV-Radio appearances.

Thus far, participation in professional/industrial meetings has been time limited, but speeches were made at the New England Council's annual meeting, November 17, at a meeting of the Research Management Association, November 30 and at the Boston Research Directors Club on December 8. Contact was also made with the Computer Committee of Harvard Law School and a luncheon talk was presented. Future plans include the designation of one member of the staff responsible for scheduling such talks and contacting all pertinent professional, educational and industrial organizations to make them acquainted with our desire to participate in their meetings. Such person-to-person contact is another valuable means of acquainting New England with TUP and has the further advantage of personal give and take with students, professionals and industrialists.

Plans call for designated staff to contact all relevant local news media on and off the University campuses so that feature articles concerning the proposed center can be supplied to these media. After an initial article has been published, the center would supply these newspapers and publications with a continuing series of releases and articles as new developments occur at the Center.

II.C.1. Other Coordinative Activities

To be fully effective, any program concerned with technology utilization and transfer in New England must become involved with the several state and governmental agencies also working on the various facets of this process. The status of the proposed center's involvement and the extent of cooperation and support available from these agencies and groups are detailed below:

Cooperation with OSTS Program

Personal contacts have been made with Martin Robbins as well as with several of the local OSTS Directors. Harold Heintz, the Connecticut Director, is enthusiastic about an RDC and plans are under way to make a joint proposal for a Special Merit Program. Dr. Howard Segool, Massachusetts State designee, has been contacted and is interested in working with the proposed RDC. Contact was also made with Dr. Harman Rockwarq of the New England Economic Research Foundation, who is trying to formulate a unified OSTS program for New England. He is very interested in the proposed program, but is constrained by his need to first formulate the unified plan. It is felt that active cooperation with all six OSTS Directors and with Dr. Rockwarq would be of great help to both programs. A meeting with the Connecticut and Massachusetts

STS Directors (who were acting as a committee for the regional study group) was held to acquaint them with the proposed program. A letter from Dr. Segool regarding this meeting is attached (see Exhibit V). Subsequent to this, the regional study group pledged full cooperation and support for the proposed center.

Connecticut Development Commission

An extremely close working relationship exists between the center and this state organization. There are two Development Technologists who work in the field essentially as extensions of this center to acquaint industrialists with the proposed center's services. Considerable support in Connecticut has come from this source.

Cooperation, Coordination and Work with Other Federal and Local Agencies and Academic Groups

To function most effectively in New England, it is necessary not only to work with individual clients but with the various Federal, state, local and university agencies that are concerned with industry and the professions in this area. Further, to maximize coverage and reinforce promotional efforts, a working relationship has been established with a number of these agencies.

Small Business Administration (SBA) - Since so much of New England's technology-based industry is "small" compared to other regions, a cooperative effort with the SBA has been initiated. Levin Foster, Chief of the R & D area, and Regional Chief, David Buell were contacted and they offered their help in acquainting local R & D business with the proposed RDC's operation. Mr. Foster has catalogued over 400 R & D companies in New England

and he has either visited each of them or plans to do so within the next year. He has compiled a history of each firm which details their technology interests. He and Mr. Buell have very graciously allowed the use of their interest profile so that their technolgy requirements can be pinpointed. Further, Mr. Foster is distributing NERAC literature to the firms he visits, thereby preparing the way with the very firms that can most effectively utilize an RDC's services. Both Mr. Buell and Mr. Foster were enthusiastic about NERAC and felt it would fill a definite need within the New England business community. Of interest is the fact that the majority of the firms, that have indicated their interest to join the proposed center, are participants in some aspect of the SBA programs.

Boston Field Office - Department of Commerce - Contact was made with Mr. Willey, Assistant Manager of the Boston Field Office and Mr. Gerard Menard, Trade Specialist. It was agreed that Mr. Menard would distribute the proposed center's literature to interested firms or professionals.

ERC - TUO's - A continuing cooperative effort has been established with Mr. Dennison and Mr. Richardson of NASA's ERC in Cambridge. Their help and encouragement has been of great value in providing an additional source of literature and moral support.

Cambridge Electronic Accelerator (CEA) - The CEA is an AEC facility run jointly by Harvard and MIT, with participation by every other New England university with an interest in high energy physics. They are presently concerned with lubrication of sliding metal surface in vacuum. The center is working with Dr. Rafael Fessel to assist in the solution to the problem. It is expected that the CEA will become a participating organizational member, which will provide a continuing source of information on high energy physics for a regional center and a further area of contact with the New England academic community.

University of Connecticut Law School - It is strongly felt that the legal profession should be encouraged to participate in the Center's activities since the use of new technology so often involves legal problems and several areas of research in the legal/scientific area need further exploration. Thus, contact was made with the University of Connecticut Law School through Assistant Dean Gordon and through Mr. Edward Sheehy, President of the Law Review to interest them in participating in the Center's activities. Literature covering various legal/scientific problem areas will be distributed and future conferences will include the specifics of Law School participation.

The Harvard Law School Computer Committee - This new Harvard Law School organization has been established to explore the various technology/legal interfaces. Contact was established with this group of about seventy-five students and their faculty sponsor, Mr. Vogts. Future plans are for a speech at one of their regular luncheon meetings and sponsorship of several research projects.

National Planning Association - This non-local association was contacted because of the desirability of obtaining their advice on the proposed NERAC approach to technological dissemination and to acquaint Mr. Sumner Meyers, of this organization, with the Center's activities. A continuing cooperative effort with this outstanding research organization is looked forward to.

II.C.2. Special Research Projects

It is believed that an essential ingredient to the continuing success of the technology dissemination effort is research into various problems in the dissemination function. This research should not be confined to one discipline or one school; rather the proposed center should attempt to incorporate the unique academic research opportunities of the New England States into special projects and programs. To this end, it is proposed that the center should seek to stimulate MBA research papers at least at Harvard Business School and at the Sloan School on the development and marketing problems of new aerospace derived products. The center should also promote research leading to a better understanding of the federal-state-university-industry interfaces needed to stimulate the utilization of new technology. The proposed RDC should plan to work with the Technology and Society Program at Harvard and with the Computer Committee at the Harvard Law School. It should be noted that the program of the Technology and Society Programs includes people from virtually every academic discipline and from several universities.

Much more needs to be done to plan a continuing program to stimulate research in the process of technology transfer at the many schools in the New England area. The project staff recognizes the value of this unique resource, the universities of New England, and realizes that planning must be expanded to cultivate this resource. To that end, one staff member's responsibilities would be to coordinate and plan the work in this area, although the entire staff will be involved in the implementation of these plans.

PROPOSED PROGRAM TO MEET THE NEEDS OF NEW ENGLAND INDUSTRY FOR TECHNOLOGY UTILIZATION

III.A. Proposed Services Packages and Operational Implications

Given the implications and perceived needs of the New England region as stated above in Section I.B.2, an operational concept of service.packages and an organizational structure is proposed to satisfy them. The transfer concept invovled is two pronged. That is, it recognizes that obtaining and maintaining technological cognizance in a specialized area is quite different from adapting innovations of products or process into the firm's environment. To deal with these two forms of technology utilization, the proposed center should be organized in a manner that recognizes these forms explicitly in terms of services and personnel.

III.A.1 Optional Information Services

To satisfy New England region's diverse needs for obtaining and maintaining specialized technical cognizance, the Optional Information Services were conceived. Included in this category are, 1) the Retrospective Search, 2) the Current Awareness Search and 3) the Standard Profile Search. These services all involve certain steps that provide the value added that the client pays for when he enlists the aid of an RLC to help him with the derivation and utilization of externally procured knowledge.

The basic steps involved are as follows:

a. An Application Specialist (AS)* makes contact with the management of the firm, determines the scientific and technical disciplines involved and coordinates the meeting to be held between the client's technologists and the center's Technical Specialists.

b. A meeting is held between company and center technologists wherein the exact nature of the technical problem(s), or question(s) is defined. The AS will probably participate in a passive role to gain insight into the firm's technical problems. The center's Technical Specialists (TS) typically will be a member of the faculty participating on a part time basis on those questions dealing with his area of competence (a detailed description of his responsibilities may be found in Exhibit 4 of Appendix D).

c. Upon returning to the center the TS consults with the center's Information Specialist (IS) to devise a computer search strategy. The IS's experience with the NASA file, the computer search algorithm and his broad technical background makes the dialogue between him and the TS most valuable.(A detailed description of the IS's qualifications and responsibilities may be found in Exhibit 3.)

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* A description of the Application Specialist's other responsibilities to the client are discussed in the section below dealing with the Application Services. A detailed description of his duties may be found in Appendix D, Exhibit 2.

d. After the search has been run and possibly relevant documents identified, the TS evaluates abstracts of these documents to verify their specificity to problem/question being searched.

c. The center then sends copies of these abstracts with a positive evaluation to the cognizant company technologist for his perusal. (In the initial stages of defining a problem several iterations may be necessary before the center and client technologists agree on the problem's definition as it is expressed in terms of feedback from the search strategy and evaluation.

f. Should the client find an abstract that he wishes to obtain the full document on, he notifies the center and a hardcopy is quickly provided from the blowback of microfische files which are retained on all NASA documents in the center's files.

g. Continuing monthly contact is maintained, typically by phone, between the two technologists so that minor shifts in interest can be followed and the validity of strategy preserved in terms of the clients needs.

All of the Optional Information Service packages essentially follow these basic steps. The individual variances that do occur will be discussed in the section covering that service package.

Retrospective (RS) Search

This search typically initiates a continuing current awareness program by reviewing all relevant material in entire NASA file. On the other hand, another useful service can be rendered by the "one-shot search" which only reviews the past literature in a particular area. This latter contact, while not possessing the advantage of a formal continuing relationship, nevertheless can be exploited by the Technical Specialist's continuing interest and his referral of interesting abstracts to the client's scientist from time to time. In this manner, the part-time client's appreciation of NERAC's services can be deepened and the possibility of a full-time relationship increased.

The study of the needs of various categories of firms brought out the fact that timeliness can be an important fact in retrospective searches. In the case of small firms (less than 100 employees) engaged in research activities, a fast response is essential to their business. Indications are that the RS should be available in two days to one week. Equally important was their apparent willingness to pay a premium for a specified faster turnaround time. These retrospective searches - - that cannot wait a maximum of two weeks to be batched (with large cost savings) - we have termed Demand Retrospective Searches (DRS).

Obviously special procedures are required to service a DRS since a leisurely meeting between technical specialists cannot be utilized. Typically, the DRS will be phoned to the the Information Specialist who will write the problem abstract and design the search strategy, in consultation with the appropriate TS if necessary. If a particularly difficult or sophisticated question is posed, the IS may refer the client directly to the TS. A later consultation between the IS and TS would then take place and, hopefully, the IS could carry out the search from that point.

Current Awareness (CA) Search

This is the familiar technique, often referred to as selective dissemination, which involves a precise knowledge of a client's technological needs. Upon joining, the individual interest centers are identified and Technical Specialists meet with company scientists to define the problem and to develop search strategies as described above. The advantages of this customized approach have been well documented by existing RDCs. The advantages of the Current Awareness search are more readily apparent to the sophisticated user of information services. Marketing CA searches to companies with this kind of personnel is considerable easier. The point is that constant client development must be undertaken in most companies so that a fuller understanding and appreciation of the CA search gradually develops.

Standard Profile (SP) Search

A number of SP searches will be designed based on the detailed survey of the New England industrial community needs. When six or more requests for a particular SP search have been generated, the search will be made operative on a monthly basis. Although typically broader in scope than the usual current awareness search (50 to 70 abstracts per month versus 20 to 40), the Standard Profile search has several distinct advantages in promoting technology utilization. One advantage in a small, harried firm is that the search provides a quick way of staying up on the technology while under considerable time pressure. An advantage for the scientist who "knows everything" in a particular area, is the extra insurance that the service provides that an obscure piece of research will not go unnoticed. For this, the broader scope and interdisciplinary nature of the SP search reaches across scientific discipline boundaries and draws in any work that is relevant to the subject.

Standard Interest Service (SIS)

Unfortunately, a large segment of New England industry does not employ technologists and yet have a "need to know" in order to survive. A large number of this type of firm, when interviewed, expressed a desire to participate in the Technology Utilization albeit without the technological expertise to develop and implement some of the material that conceivably would be directly relevant to their operations.

In order to serve this legitimate need, we propose to institute a service based on the Standard Profile search. Instead of sending the monthly set of abstracts generated by the SP to the non-technologist firm, the Application Specialist will review the SP for items of interest to the firm. If an item is of particular relevance to the client's problems, the AS will explain its importance to management and if they so desire, he will refer them to technical consultants or other sources of assistance in the region, eg., the SBA, the

Connecticut Development Commission (which can arrange financing), the University Research Institute of Connecticut, etc. For items of general interest the AS will prepare an "SP-Newsletter" which will be couched in non-technical terms that will make clear what the implications are for possible industrial application.

III.A.2 Application Services

Under the proposed Optional Information Services, a given client may be interested in using any or all of the options depending upon his needs. In any case, no matter what optional services are chosen, the client would receive the proposed Applications Service. The Application Services deal with the other facet of the transfer concept: that of adapting product and process innovations to a firm's environment. Under the various information services, a Technical Specialist is assigned to work with a particular individual or work group; under the Application Services, an Applications Specialist is assigned to work with the whole division or company. The Application Specialist's (AS) function is described below.

Part of the task of the Application Specialist is to deepen the relationship between the Center and the Client during the period of the contract. In a very real sense he will be concerned with, and responsible for, the entire company or division interface with the Center. This includes coordination of the Technical Specialists' activities and feedback from the company on services rendered. Some of his other duties are as follows:

1. Development of the organization's "innovation profile" - This task is accomplished by studying all pertinent material published about the firm in Moody's, Standard and Poor's, annual reports and other reference sources to get a good idea of the firm's reported products and process interests along with its financial and technological resources. Next, the AS visits with the top, or near top, management of the company to get a better feel for the background information that he has acquired. He is mostly concerned with determining where the company wants to go technically and/or product-wise in its established markets or in new markets. He strives for a broad or generic definition of the company's goals or purpose and its real resources.
2. Satisfying Company Innovation Needs - This is a difficult, demanding and, most of all, imaginative task. To accomplish this he has several resources. One is the group of Technical Specialists working on informational services with the firm. In meeting periodically with this group he attempt to communicate the overall needs and goals of the company in an effort to give the Technical Specialists enough information so that they can identify possibilities as they work with the literature. The broad, generic definitions of the company's goals facilitates cross-disciplinary transfer as does the airing of the

various company problems in the AS -- Technical Specialists meetings.

3. Working with Standard Profile Clients - Some of these clients may not utilize any service other than the Standard Profile and therefore would not have any close person-to-person technical relationship with the Center. The AS's job in this case is to meet regularly with the client to discuss his technical problems thereby acting as a forcing function to acquaint the client with the full value of the RDC. In this case, the Standard Profile has provided the entre to the firm, has established a relationship with the Center, but it is up to the AS to develop a dialogue with the company to help them learn how to use this resource.

4. Management Research and Technology - Through his work with defining a company's innovation profile, the AS also attempts to get pertinent management research literature into the hands of those who can use it in the firm. In other words, he informally attempts to assess the interests in management technology of the various members of management that he deals with. A partial result of this is the identification of special need groups for a workshop in management technology. (Based on the inputs of the Application Specialists, the Center would then consider holding management workshops to discuss the relevant

management concepts that have been developed through government sponsored research and experience.)

5. Referral Agent - The AS is in an excellent position to act as a referral agent to the management of small companies that may get out of their depth when investigating a new product or process. The AS's knowledge of the TU related programs of various state and federal agencies, as well as academic and other institutions gives him a broad base to draw on in suggesting where additional help might be obtained.
6. Research into Technology Transfer - The AS is in a unique position to aid in research into the technology transfer process. Some of the possibilities for research were mentioned above and many more exist. The AS should be able to give both direct and indirect assistance with work in this area.

The service elements of the Application Service program include the New Product Opportunity program, AEC-NASA Tech Briefs and Special Reports, Computer Program Dissemination and the Industrial Systems Management and Technology Utilization program. These services are described below.

New Product Opportunity Program

The key elements in this program are, one, establishing what the needs of a company are and two, the development of ways in which to identify technology that may satisfy these needs. The establishment of needs is performed by the Application Specialist, the details of which have been explained above.

His purpose is to couch the firm's product and process goals in broad, generic terms that avoid the easy categorization into, for example, gasket manufacturer instead of developer of sealants. This redefinition facilitates the application of cross disciplinary technology to the firm's technical problems and markets. In fact it may even result in the discovery of markets previously ignored by the firm. The means for meeting these needs requires considerable imagination and ingenuity. Two approaches are proposed. One approach is meetings between the Application Specialist and the appropriate Technical Specialists. These meetings provide an opportunity for the firm's overall concept of itself and its goals to be made clear to those working in the detailed technical problem solving area. It also provides a stimulating vehicle for cross-disciplinary transfer to solve apparently unrelated technical problems. The inclusion of company personnel in these meetings is another posssiility which needs to be evaluated by experience. The other approach to meeting a firm's needs is the setting up of user-producer conferences. The conference in this case would be somewhat different from WESRAC in that the needs (or interests of a group of firms would be clearly known and the conference directed toward satisfying a particular set of needs. In other words, instead of fielding a team to cover six areas of technology, the conference concentrates on the particular area identified to be of interest to a number of firms.

Tech Briefs and Special Reports Service

These items describe product and process innovations, techniques and methods, and state of the art surveys. The nature of these reports is such that the greatest interest, in terms of utilization, lies within the technically oriented management group of a firm. As mentioned above, the Application Specialist's task is to identify those people within the firm that are interested in ideas and concepts for improving the firm's products and processes.

Computer Program Dissemination

This is a special field of direct application. The AS will review company computational needs and interests and will see that the appropriate people know about available NASA computer programs.

Industrial Systems Management and Technology Program

Another application service directed toward management is a program to make the management of firms not engaged in aerospace or defense work, aware of the concepts and techniques that have been developed to manage large complex programs, systems and organizations.

Although the environment may be entirely different, the underlying concepts can have an important impact on the management of private industry. In this instance the AS tries to point out the research that is relevant to situations of which he is aware as a result of defining the company's operations and interests. The distribution of aerospace derived management bibliographies will be made as appropriate.

In addition, when sufficient interest has been generated, workshops should be organized by the proposed center to demonstrate to, and acquaint management with, the usefulness and relevance of government sponsored management research.

The table below summarizes the five basic categories of unique needs for technology and the type of firms in each category and the service packages devised to meet the perceived needs.

Table 10
Proposed RDC Service Packages

	Category of Firm	Optional Info. Services	Application Services	Other
1.	Large,* engaged in rsch.	RS/CA/SP	yes	User/ Producer Conference Inputs
2.	Small, engaged in rsch.	DRS/RS/CA/SP	yes	
3.	Large,* employing technologists (no rsch)	SP/CA	yes	Management sci. workshop
4.	Small, employing technologists (no rsch)	SP /DRS poss	yes	User/ Producer Conference Outputs
5a.	Large* no technologists **	SIS	yes	Management sci. workshop
5b.	Small, no technologists			

* Large ≥ 100 employees

** Interviews suggest greater difficulty in working with 5 a. type firms, otherwise service package is the same as for 5 b.

III A.3 Proposed Price Structure

The price structure for the services detailed above was based on a careful cost analysis of the proposed center's operations for four years. Two constraints were placed on the price, that it 1) always cover direct (out-of-pocket) costs and 2) that it be high enough so that the proposed center would have a reasonable expectation of becoming self-supporting within three years. The costs used in the pricing analysis were those expected after three years, making allowances for learning and for economies of scale. These are dealt with in more detail below in Section III.C.

The above constraints set the lower limit on pricing the service packages. The upper limit is based on what the client is willing to pay, which, in turn, is based on the value that he places on a particular service. Without direct experience with an RDC's various service packages, it is very difficult for management to assign a value to the service and, therefore, it is difficult to decide how much the firm should pay. Accordingly, the first few years of a new RDC's operations involve market penetration and the demonstration to client firms what value the services are to them. Consequently, we believe that it is important that the prices for services be as low as possible while not violating the two constraints set out above; e.g., cover direct costs plus enough margin to be self-sustaining on industrial support after three years.

As the center's customers experience with the services grows, it would be possible to increase the price of the service if this became necessary to sustain operations. This principle has been demonstrated at at least two of the older centers which have recently raised prices substantially with very little reaction from their experienced clients.

Insofar as charging a membership fee to new clients when they contract for center services, we do not feel that this is in keeping with the true cost/price relationship that the center should maintain. The charges to large companies should not be used to subsidize small users. Each should pay the same price for the same service. If a membership fee were to be used and graduated for different size users or size companies, the problems of measurement and other inequities would be hard to avoid, certainly difficult to administer.

On the other hand, the center should solicit funds from companies, individuals, governments and foundations to support the non-operating facets of the center's activities, e.g., research into technology transfer/measurement, seminars, conferences, etc.

With this preamble and in conjunction with the postamble in Section III.C., the following prices are proposed for the centers first years operation.

Code	Title	Cost
DRS	Demand Retrospective Search (48 hr. response)	$155/search
DRS	Demand Retrospective Search (1 wk. response)	$125/search
RS	Retrospective Search (no follow on CA)	$100/search
RS	Retrospective Search (with follow on CA)	$ 50/CA
CA	Current Awareness-12 issues (with RS start)	$250/year
CA	Current Awareness-12 issues (no RS)	$265/1st. yr. $250/2nd yr.
SP	Standard Profile*-12 issues (without CA)	$180/year
SP	Standard Profile**12 issues(with CA)	$120/year
SIS	Standard Interest Service ***	$180/year

In pricing the Standard Interest Service, we selected what we estimate to be the maximum price that the small, no-technologist firms will pay. We propose that the program be carried on this basis for a year to determine whether or not it is successful. If it proves desireable to continue the service at this price, we would then seek support for the excess of cost over price. Candidates for supporting this program include the state development commissions, the State Technical Service Office, SBA and possibly other agencies or organizations.

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* This is referred to as an "outside" SP in Section III.C.
** This is referred to as an "inside" SP in Section III.C.
***The estimated cost of this service is $240/year.

III.B. COMPUTER ECONOMICS

ECONOMIC ANALYSIS OF OPERATIONAL CONFIGURATIONS AND DEVELOPMENT OF PRICING CRITERIA

In order to accurately appraise the costs of a given operation, it is first necessary to define the functional requirements and specifications. Section I, described above, has provided the requirements and specifications. Inasmuch as very large volumes of information will be reviewed by the Center, the alternative of using a computer for part of the work immediately suggested itself. Because of thedanger of a superficial evaluation where a "small" logic error can be enormously magnified, it was decided to make a thorough examination of the available computer programs, i.e., one must either analyze computer operations all the way or not at all. The significance of the outcome of these evaluations on the proposed operations is such that it was believed prudent to utilize the services of Dr. Daniel Wilde, whose doctoral dissertation at MIT was concerned with these issues. The outcome of Dr. Wilde's investigations have resulted in a very accurate computerized operational cost analysis and have been compared against the outcome of an equally rigorous analysis of the manual operation costs performed by Mr. Benjaminson. Dr. Wilde's progress is summarized below.

Computer Evaluation Results

Two separate computer retrieval programs were developed based upon concepts of existing Regional Dissemination Center (RDC) computer programs. The original programs were reprogrammed because of minor logical errors and many redundant, time-consuming instructions. The first retrieval program is a standard logical term search, where the retrieval question terms are matched against the accession terms through a logical expression. The second retrieval program is a logical character search where individual characters of the retrieval terms are logically matched against the characters of the accession terms. These two programs have been completely reworked by deriving the original flowcharts, eliminating unnecessary operations, and recoding using more efficient FORTRAN statements. These two programs have now been debugged, experimentally tested, and production tested.

During the first production test, the input tape unit was used for 23,298 individual reads. From the mechanical performance and sound of the input tape drive, it was obvious that the retrieval program was input limited. It was at this point that the computer time reduction effort began.

From the above observation it was decided to work on the input procedure first. Because of the experimental nature of the work, a series of timing runs were performed. The results are shown in the following table.

Tape Format	Tape Reads	Time (min.)	Percentage of Original Program Time
Original Program	23,298	34.3	100,0%
Blocked BCD	281	27.7	80.7%
Blocked BINARY	562	22.6	65.9%
Compressed BINARY	169	14.4	42.0%

The experimental tape used was a reformated Documentation, Inc. linear file and processing it required 34.3 minutes. The first time reduction step was to simply reblock, e.g., more useful information between useless record gaps. Here both BDC and BINARY modes were used and a reduction was obtained that was 80.7% and 65.9% of the Original Program time, respectively. A later effort recoded and compressed the tape information into less space and produced a reduction to 42.0%.

In order to experiment with a working system, it was necessary to get the computer program operational as soon as possible. To meet this goal the original retrieval algorithm was used even though it contained a very major drawback. This procedure compares each tape index term against every question term. If there are M tape terms and N question terms, the alogrithm must always perform M x N term comparisons. Well-known algorithms are available for reducing the number of retrieval comparisons to M + N or less. Since the above timing tables include the M x N comparison drawback, thought was given to revising the internal search algorithm. By still programming in FORTRAN, a revised program was debugged, tested, and timed in two days. A second revision has since followed. The present timing table is shown below. (In all timing experiments, identical retrieval questions and tape accessions were used.) As can be seen the last row indicates a reduction of one complete order of magnitude.

Tape Format	Tape Reads	Time (min.)	Percentage of Original Program Time
Original Program	23,298	34.3	100.0%
Blocked BDC	281	27.7	80.7%
Blocked BINARY	562	22.6	65.9%
Compressed BINARY	169	14.4	42.0%
NERAC #1	85	4.0	11.7%
NERAC #2	85	3.4	9.9%

Once running times were reduced to a reasonable level, cost studies were begun. In order to do a complete job, a timing simulation program has been developed that will produce all running times and costs as a function of number of search questions, number of accessions, number of terms/question, and number of terms/accession. A sample sheet from one of the latest simulation runs is attached (Appendix B Exhibit 1).

During this feasibility study, we have been in constant contact with Mr. Van Wente discussing NERAC's computer progress and results. During one of these conversations Mr. Wente pointed out the results of an information retrieval case study in which the author evaluated various existing retrieval configurations and discovered that in general the user waited for the machine rather than the machine waiting for the user.

At this point it was obvious that if the proposed Regional Dissemination Center had its own machine, that machine would truely wait for that RDC. The only real hurdle was what were the cost comparisions between renting an in-house machine and buying time by the hour from some other source. The evaluation of such costs and the effects of an in-house computer are discussed in Appendix B. In summary, our studies indicate that it would be cheaper and more beneficial for the proposed RDC to rent its own machine, a small 8K two-tape 1401. Mr. Van Wente and Mr. Larry Stephens have been consulted on this conclusion and agree with the outcome of the study. (It should be mentioned that this study involved programming and testing both the search and reformating programs described earlier. This work is now 75% complete.)

We project it will take the proposed center nearly three years to become self-supporting. Since earlier established centers still have not met their breakeven goal after four to five years, a bold plan is needed for cost reduction by a new center. If an in-house machine at fixed costs is used, it can reduce human and paper variable costs by maximizing computer usage.

Operation Cost Analysis

Tentative organization configurations were developed on the basis of meeting the region's service needs as previously described. Operations and procedures were defined and alternatives listed. It was decided to base the cost analysis on three projected operating levels, using a mix of three different levels of service. Gross cost estimates were then made.

The investigation trip to the RDCs at Pittsburg and Indiana University by Mr. Benjaminson led to some organizational refinements and operational modifications. The revised structure was then analysed in greater detail taking into account such factors as personnel skills, operation timings, and materials requirements. Prevailing regional wage and salary rates have been used in the analysis. Estimates have been made as to the cost of all overhead items for the three operating levels. These figures have been combined with direct costs, and the results were used as a tentative basis for developing pricing figures.

Simulation Model - The proposed operational setup, having been refined as far as practicable during the feasibility study, has been flowcharted and has been manually simulated using a combination of deterministic and random sampling methods. The simulation has been done for three different proposed growth curves and three different service mixes. (See Appendix C for a detailed description of the simulation model and its assumptions.) The object of the simulation has been to determine manpower requirements, cost figures, and possible organizational inefficiencies, e.g. bottlenecks, as well as to form the basis for operating budget projections.

Simulation Results - - The time required to break even was found to be a function of both growth potential and of service mix. From Figs. 3.C.1, 3.C.2 and 3.C.3, that, given a constant service mix, the time required to breakeven is inversely related to growth potential. This is due to "economy of scale" factors, such as are found in feeding the computer the questions in increasing batch sizes; in the Technical Specialists having similar questions which can be evaluated simultaneously; in having more Technical Specialists so that each may concentrate on a narrower area of expertise.

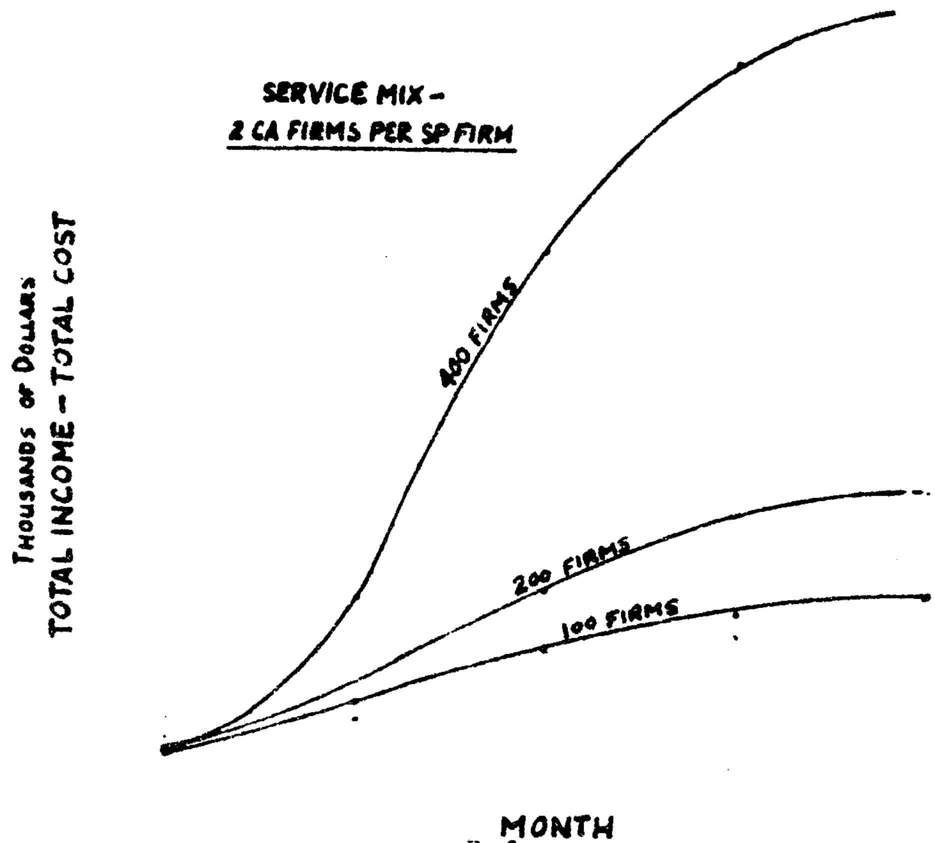
Aside from the economies of scale (and learning) that affect the direct costs of service packages, significant savings will result from the small increases in center indirect costs relative to increases in service provided by the center. Indirect cost retardation in the face of growth is the result of the heavy reliance on electronic data processing and computer analysis for clerical-type activities. This will tend to prevent the addition of clerical help in proportion to the volume of business added. In other words, a minimum staff is required for any operation, no matter how small, but this staff will not grow significantly as volume increases, as the majority of routine, non-professional operations in the center will be mechanized. The cost of mechanization is not proportional to the cost of hiring additional clerical staff- in fact, in the case of a center rented computer, there will be no additional cost for increased computer usage.

The addition of directly chargeable personnel to handle operations at the projected maximum growth levels will not exceed the effective span of management of the center's administrative officers. This too will reflect the economies of scale in the indirect cost of operations.

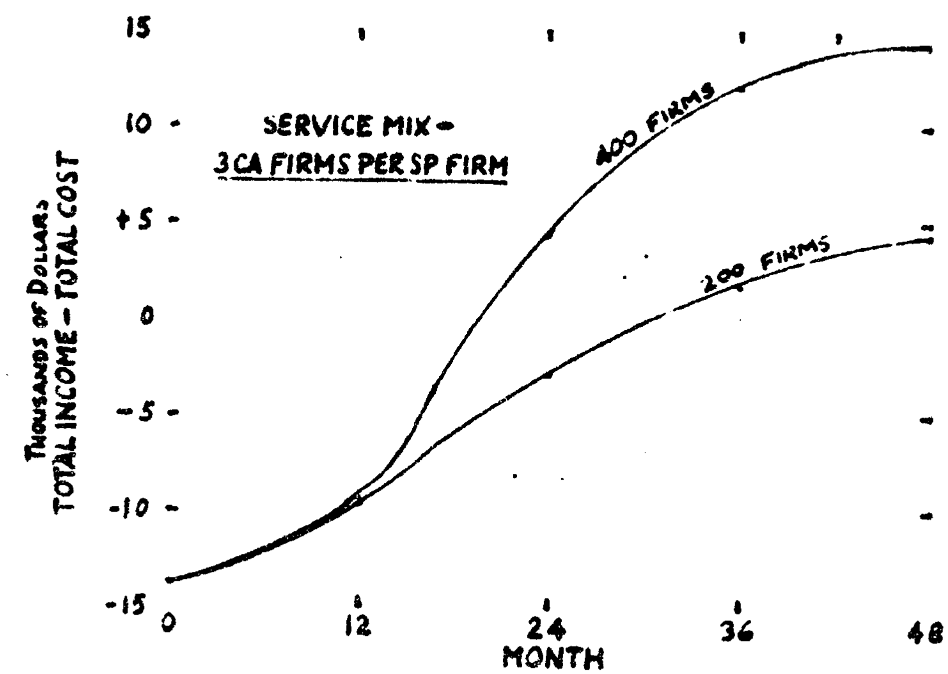
Figures 3.C.4 and 3.C.5 indicate that for a constant growth potential, the time required to break even is shorter the greater the ratio of CA to SP firms being serviced. This is so because the "Outside SP" service has been priced at breakeven. Figures 3.C.6 and 3.C.7 indicate dramatically the effect of the cost of document reproduction.

Economics and Operational Feasibility of Computer vs. Manual Search - - Experiments have been conducted to determine whether manual searching techniques will be preferable to computer searching techniques. Three methods of manual searching have been evaluated: (1) Using a direct printout of the computer tape; (2) Using the STAR and IAA indexes, and (3) Using an inverted file printout.

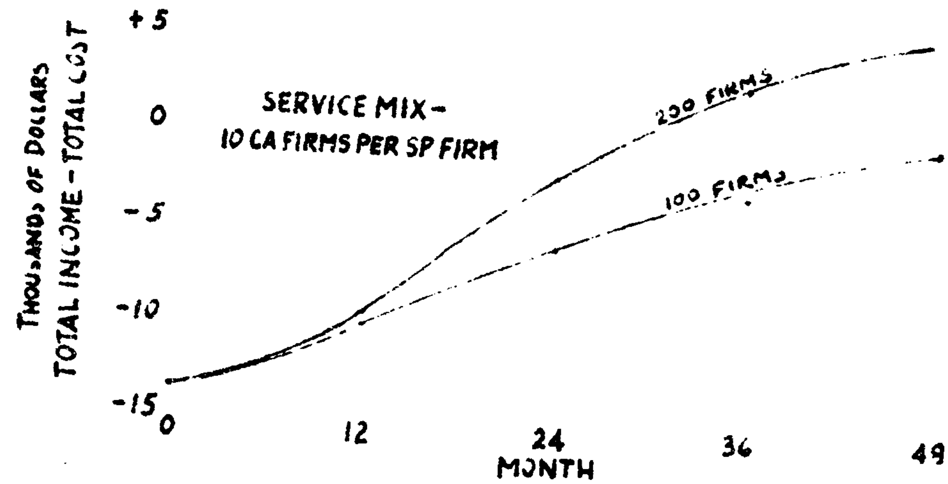
Direct Printout of Document Tape - - This requires searching down a list of accession numbers and trying to locate those having the desired index terms. For a one-term current awareness question, search time for a graduate student in two separate tests were 4 hours, 22 minutes, 43 seconds and 4 hours, 15 minutes and 12 seconds. Cost per search at $1.80 per hour


SERVICE MIX –
2 CA FIRMS PER SP FIRM
THOUSANDS OF DOLLARS
TOTAL INCOME – TOTAL COST
400 FIRMS
200 FIRMS
100 FIRMS
MONTH

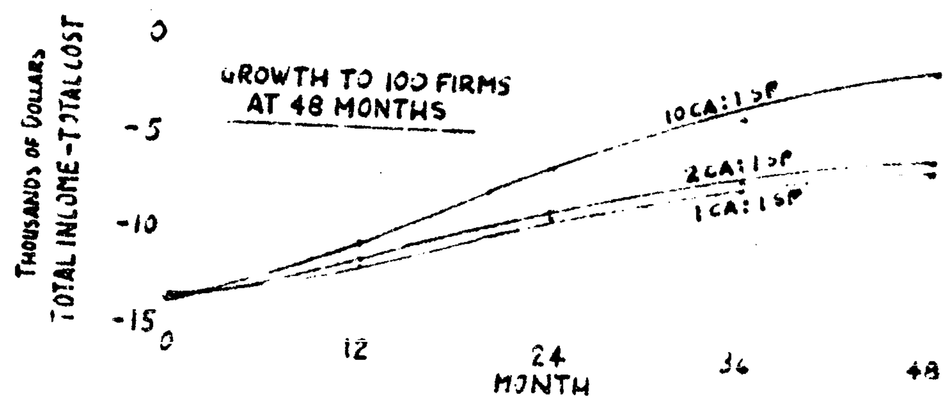
3.C.1


15
10
+5
0
-5
-10
-15
SERVICE MIX –
3 CA FIRMS PER SP FIRM
THOUSANDS OF DOLLARS
TOTAL INCOME – TOTAL COST
400 FIRMS
200 FIRMS
0
12
24
36
48
MONTH

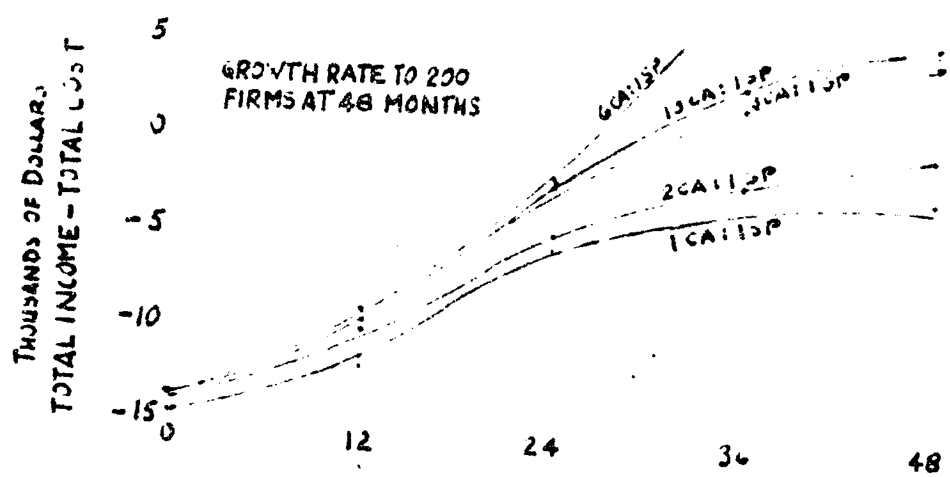
3.C.2


+5
0
-5
-10
-15
THOUSANDS OF DOLLARS
TOTAL INCOME - TOTAL COST
SERVICE MIX -
10 CA FIRMS PER SP FIRM
200 FIRMS
100 FIRMS
0
12
24
36
49
MONTH

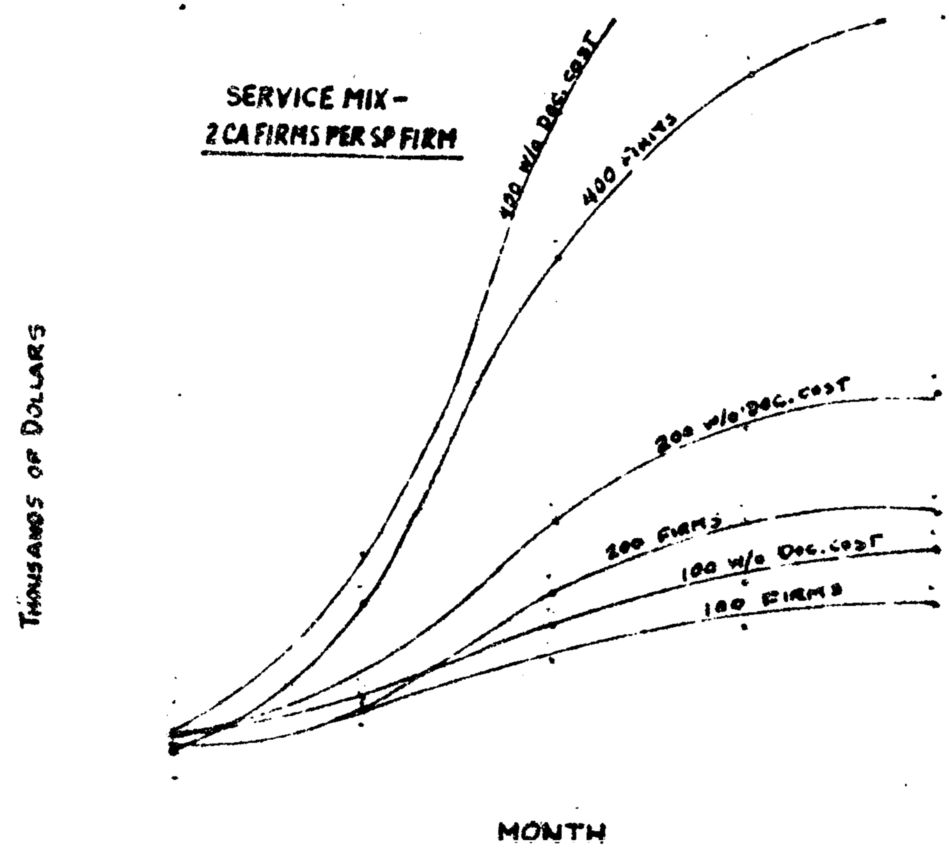
3. C. 3


0
-5
-10
-15
THOUSANDS OF DOLLARS
TOTAL INCOME - TOTAL COST
GROWTH TO 100 FIRMS
AT 48 MONTHS
10 CA : 1 SP
2 CA : 1 SP
1 CA : 1 SP
0
12
24
36
48
MONTH

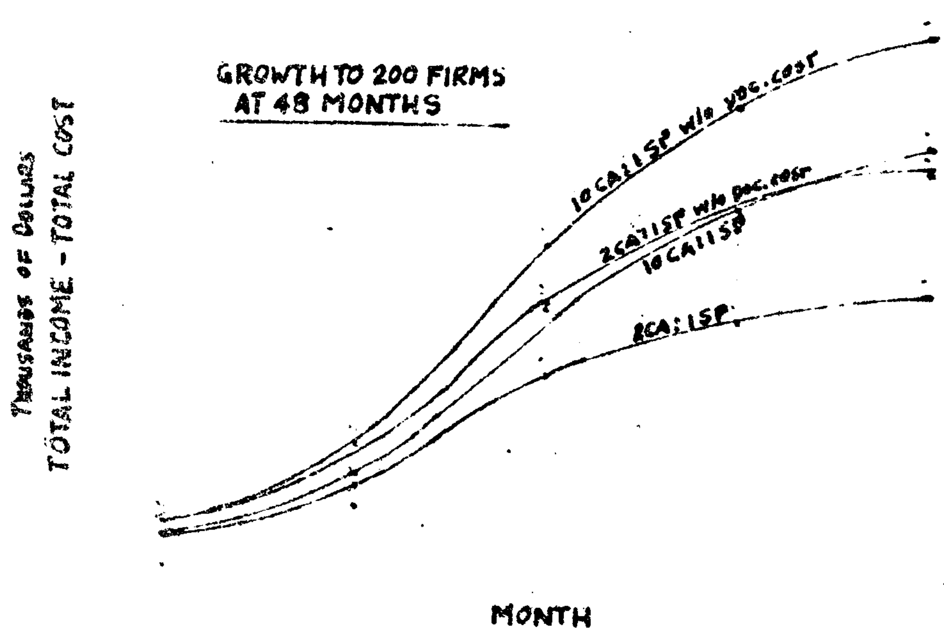
3. C. 4


5
0
-5
-10
-15
THOUSANDS OF DOLLARS
TOTAL INCOME - TOTAL COST
GROWTH RATE TO 200
FIRMS AT 48 MONTHS
2 CA : 1 SP
1 CA : 1 SP
0
12
24
36
48

3. C. 5


SERVICE MIX -
2 CA FIRMS PER SP FIRM
THOUSANDS OF DOLLARS
400 FIRMS
200 w/o DOC. COST
200 FIRMS
100 w/o DOC. COST
100 FIRMS
MONTH

3. C. 6


GROWTH TO 200 FIRMS
AT 48 MONTHS
THOUSANDS OF DOLLARS
TOTAL INCOME - TOTAL COST
10 CA : 1 SP w/o DOC. COST
2 CA : 1 SP w/o DOC. COST
10 CA : 1 SP
2CA : 1 SP
MONTH

3. C. 7

pay rates were $7.882 and $7.655, respectively. Comparatively, a computer search of only one question (batch size= 1) with the same term count and assuming 6,000 accessions per tape would cost $3.08. If the batch size were 20 rather than 1, the computer search cost would be only $0.20. It is important to note that misses in the manual search increased toward the end of each search and varied according to the mental and physical condition of the searcher. Twenty-five percent misses have been obtained in each of the two searches (4 out of 16). Using this method for Retrospective searching is impractical, since a single term search for "OR" term searches takes about 10-15 minutes longer; two term "AND" searches take about 35 minutes longer, and in either case, time taken increases exponentially as a function of number of terms.

STAR and IAA Indexes - Current awareness searches performed manually are cheaper than searches using the U. of Conn., Computer Center, until the machine batch size reaches about 8 (assuming 7-term questions and 6,000 accessions/tape). This is based on the cost data derived in Appendix D. The cost of this type of manual search is a linear function of the number of "OR" terms and an exponential function of the number of "AND" terms (due to the M x N x O x P x....compares necessary).

Retrospective searching is less expensive manually than when using the U. of Conn Computer Center up to a batch size of 6, at which point the computer becomes less expensive (based on 200,000 accessions per tape and 7-term questions).

Misses due to lack of depth in indexing have averaged 62.5% which is a smaller percentage than theoretical. This is highly significant in that many potentially valuable documents can be overlooked due to this factor alone, without regard to other human error, which in itself can be highly significant. In more than one sample search, index terms giving five or more machine drops did not even appear in the STAR or IAA Index for the same period. Some terms, such as "Mortality," are machine terms only, with no published articles at all indexed under these terms.

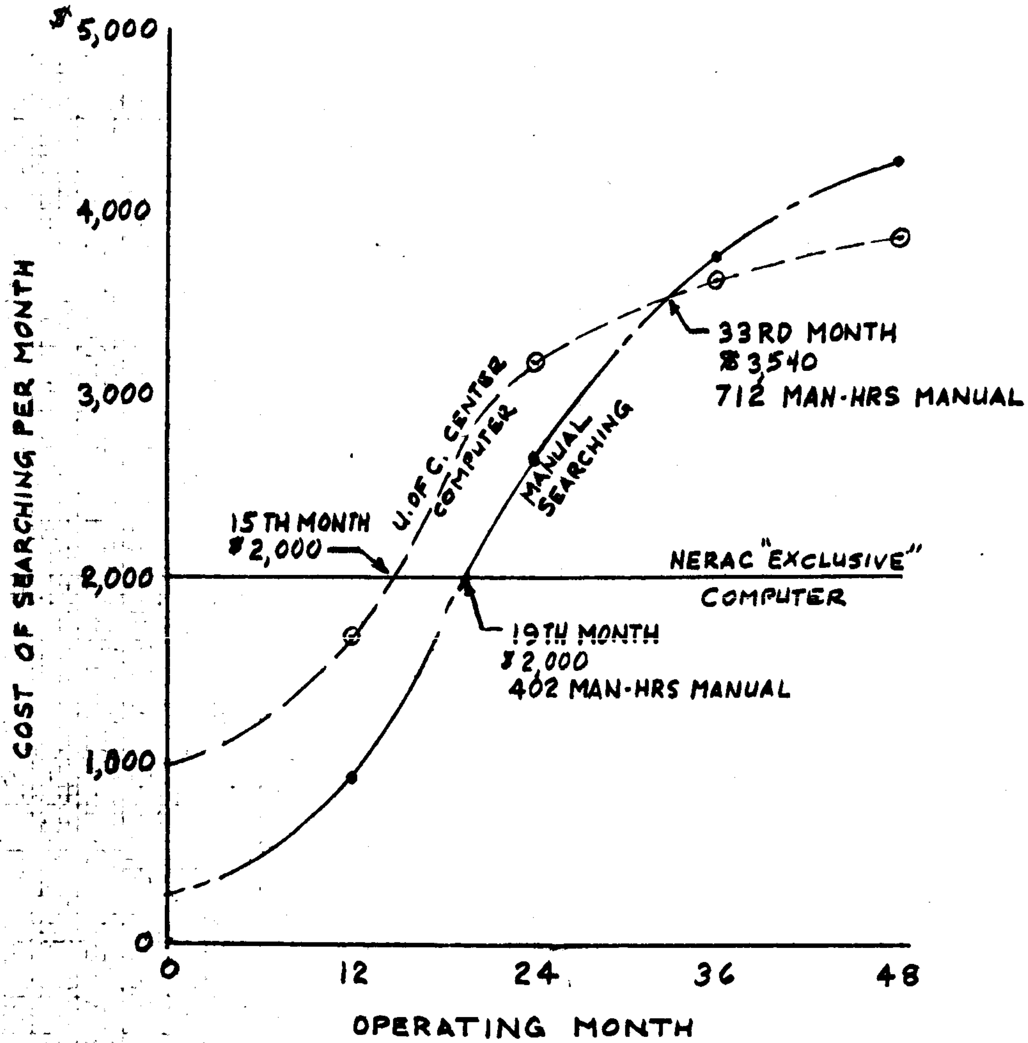
Inverted File - - This type of search eliminates the depth of indexing problems. Since no inverted file was available we can only estimate its effects. It is believed that this type of search should take only slightly longer than a STAR/IAA search, but being similar in characteristics. A major discouraging feature of this type of search is the high cost of producing an inverted file. The cost is such that any other cost advantages that might exist are offset and computer searching again becomes the most feasible.

The graph entitled "Comparison of Searching Costs" compares the operating costs for searching manually with those of searching by computer; either a rented one or the present machine at the University's Computer Center.

The costs of searching manually are directly proportional to the number of searches to be done. There are no savings to be accrued due to increases in volume - in fact, the opposite is likely to occur due to strain on the individual searcher.

COMPARISON OF SEARCHING COSTS

MANUAL VS. U. OF CONN. CENTER COMPUTER
VS. NERAC COMPUTER



BASIS: GROWTH TO 200 FIRMS AT 48TH MONTH
10 CA FIRMS PER "OUTSIDE" SP FIRM

Using the University's computer is equivalent to renting by the hour. Increases in volume lead to savings since more questions can be run simultaneously.

The cost of searching using a rented computer is different from the other two cases, in that the total cost is completely independent of volume.

The three searching methods thus show three different relationships between volume and costs.

In manual searching, unit costs are constant and total costs are proportional to volume. In searching using the University's computer, time costs are constant, unit costs decrease with rising volume, and total costs increase with volume but at a decreasing rate. Finally, when searching on a rented computer, total costs are constant and unit costs are inversely proportional to volume.

The graph shows that the rented computer becomes less expensive to operate than the University's computer in the 15th month and than manual searching in the 19th month. The University's computer is cheaper than manual searching after the 33rd month.

From the standpoint of desirability, the three methods have the same ranking as above. The least desirable method is manual searching, which has no advantages other than lower cost at extremely low volume. Its drawbacks are numerous and serious. These include (a) serious lack of indexing depth leading to a significant number of misses, (b) complete lack of certain indexing terms also leading to misses, (c) introduction of human error leading to trash and misses, (d) dependence on students which could cause serious problems with turnover and space, conflicts due to exams and difficulty in maintaining a staff during the summer months. One the other hand, if a permanent full time personnel were used the deadly monotony of searching would cause serious quality control and motivation problems.

Using the University's computer eliminates these problems, but introduces others such as scheduling problems, lack of time for long runs and inconvenience for use in peripheral operations such as mailing, accounting, control, etc.

The most desirable from all standpoints is a rented computer. Its combination of constant cost and immediacy have excellent and significant side effects. Scheduling is under the complete control of the RFC. Searches that are not as good as they should be can be stopped in the middle, corrected and re-run on the spot. Speedy service can be more easily guaranteed. These are all time efficiencies and may indirectly effect costs. Mailings can be partially handled by the computer, thus saving large amounts of typing time. Research into such fields as search theory can conveniently be performed. For further details see Appendix B and the preceding discussion on computer programming and retrieval analysis.

Equipment - Alternate methods of reproducing abstracts have been investigated. With regard to initial estimates of short-term volume, copying rather than duplicating, machines seem indicated.

At present, the feeling is that reproducing documents from microfiche would be preferable to storing the actual documents. Various reader-printers have been investigated, with the Itek 18-24 appearing to be somewhat better than the others, from the standpoint of features and cost, for the estimated needs.

Operations - One of the largest single labor costs to the system is the fully direct cost of the Technical Specialists. Methods of reducing this cost have been investigated, especially through increased computer utilization. If computer costs, which are a small part of overall cost (approximately 5%), were doubled, the cost of Technical Specialists could, in a conservative estimate, be cut by as much as twenty percent. A further reduction of overall cost might be achieved through the computerizing of many of the routing, listing, logging and statistical functions.

Operations Planning and Control by Simulation -

As a follow-on to the simulation model developed for the feasibility study analyses, we proposed that this model be elaborated and extended into a digital computer model. This will permit a greater degree of detail in operations and the number of variables included. Using this model it would be possible to make monthly comparisons of actual operations (time and cost) with the models output using the same input requirements. The differences can then be analyzed to determine where discrepancies are occurring --be it different costs or times than assumed or logic errors in modeling the operations. The analysis then serves to make the mode more realistic and at the same time develops planned costs and times to control by.

The successful application of simulation to the planning and control of RDC operations would mark a significant breakthrough in the management technology.

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APPENDIX A

EXHIBIT I

THE UNIVERSITY OF CONNECTICUT
THE SCHOOL OF BUSINESS ADMINISTRATION

Dear Mr. President:

How do businesses take advantage of new technology? In order to determine the effect of technology on the business community of New England, the University has undertaken a research project on technology transfer.

I ask for your participation in the project. Its success depends upon our obtaining a limited amount of information about your firm. The data requested are not considered to be proprietary; however, the answers to the enclosed questionnaire will be treated with the utmost discretion and no specific disclosures of any kind will be made.

Your assistance in this research is greatly needed. I am confident that the results will be of benefit to New England business.

Sincerely,

Robert O. Harvey
Dean

Enclosures

STORRS, CONNECTICUT 06268

TIME PERMITTING, PLEASE ANSWER THE ADDITIONAL QUESTIONS BELOW.

	Yes	No
1. Have you ever applied for a license for a government owned patent?	______	______
2. Have you ever sought to buy a license from a government contractor?	______	______
3. If exclusive license were available from the government would you apply for one?	______	______
4. Do you feel that government owned patents, in general, have any commercial value?	______	______
5. In view of the large amount of government sponsored R & D do you look to the government as a source of new product ideas?	______	______
6. Do you have a company procedure for documenting new ideas?	______	______
7. Do you feel that this procedure is effective?	______	______
8. Does this procedure include a monetary incentive for the inventor?	______	______

EXHIBIT III

FIELDS OF INTEREST

010 AERODYNAMICS (Research)

020 AIRCRAFT

030 ENERGY CONVERSION
- 1 Fuel Cells, Energy Conversion Cells, and Solar Cells
- 2 Conversion Techniques
- 3 Power Sources, Including Batteries
- 4 Power Plants or Equipment

040 BEHAVIORAL & SOCIAL SCIENCES

050 BIOLOGICAL AND MEDICAL SCIENCES

060 CHEMISTRY
- 1 Chemical Analysis & Identification
- 2 Synthesis
- 3 Properties

070 INDUSTRIAL SUPPORT EQUIPMENT AND TECHNIQUES
- 1 Heating, Ventilating, Air Conditioning, Refrigeration
- 2 Water Purification and Treatment
- 3 Construction Equipment, Materials and Supplies
- 4 Containers and Packaging
- 5 Ground Transportation Equipment

090 ELECTRONIC EQUIPMENT
- 1 Communications Equipment
- 2 Telemetry
- 3 Test Equipment and Maintainabilty
- 4 Components (eg., transistors)
- 5 Circuits and Miniaturization
- 6 Computers
- 7 Data Processing

100 ELECTRONICS AND ELECTRICAL
- 1 Circuit Theory
- 2 Feedback and Control Theory
- 3 Lighting, Wiring Techniques and Materials, Motors, Generators
- 4 Transmission
- 5 Switches, Relays and Other Electrical Equipment

110 LABORATORIES & TEST FACILITIES

120 INDUSTRIAL PROCESSES
- 1 Casting, Extrusion, Forging, Machining, Metal Forming
- 2 Fiber and Powder Metallurgy
- 3 Numerical Control
- 4 Welding, Brazing, Soldering
- 5 Quality Control and Inspection
- 6 Separation, Purification, Drying

130 PHOTOGRAPHY & OPTICS

140 INSTRUMENTATION
- 1 Design, Installation and Testing
- 2 Gyroscopes
- 3 Measuring Instruments and Gauges
- 4 Recorders, Transducers, Indicators, Controllers, and Auxiliary Equipment
- 5 Industrial Process Instrumentation and Control

150 MACHINE ELEMENTS AND PROCESSES
- 1 Bearings, Seals, Pumps, and other Mechanical Equipment
- 2 Hydraulic and Pneumatic Equipment
- 3 Lubrication, Friction and Wear
- 4 Materials Handling

160 MATERIALS, METALLIC
- 1 Cermets
- 2 Corrosion and Electrochemistry
- 3 Metallurgy and Metallography
- 4 Physical and Mechanical Properties

170 MATERIALS, NONMETALLIC I
- 1 Adnesives and Seals
- 2 Ceramics, Refractories and Glasses
- 3 Coatings, Colorants, and Finishes
- 4 Fibers and Textiles
- 5 Wood and Paper Products

180 MATERIALS, NONMETALLIC II
- 1 Petroleum Products and Petrochemicals
- 2 Pharmaceuticals and Cosmetics
- 3 Plastics, Reinforced Plastics
- 4 Rubbers
- 5 Other Materials

190 MATHEMATICS

200 EARTH SCIENCES & OCEANOGRAPHY

230 PHYSICS
- 1 Acoustics
- 2 Cryogenics
- 3 Fluid Mechanics
- 4 Magnetism
- 5 Masers and Lasers
- 6 Plasma Physics
- 7 Structural Mechanics, Stress Analysis, Vibration and Shock
- 8 Solid State Physics
- 9 Thermodynamics and Heat Transfer

240 Atomic, Molecular, & Nuclear Physics, Including Nuclear Engineering

270 PROPULSION AND FUELS

300 SPACE SCIENCES AND EXPLORATION

400 FIELDS NOT INCLUDED ABOVE

EXHIBIT IV

QUESTIONS FOR PERSONAL INTERVIEWS

1. What are your needs for technology?

2. How do you use technology?

   2a. How would you use technology?

   In general terms explain RDC as technological resources

3. How could an RDC assist you in meeting your technological needs?

   Specifically what would you use the data for:

   a. Diversification

   b. New products

   c. Improve existing products, processes, devices, methods, etc.

   d. To bid on Federal, state or municipal contracts

   e. Interested in entering fields such as, educational teaching aids, urban redevelopment, earth sciences, etc.

4. a. For small businesses - In what ways can an RDC supplement SBA or other Federal agency services?

      1. Field offices

      2. Centralized offices

   b. For larger businesses - (non-SBA eligible) In what ways can an RDC supplement

      1. Field offices

      2. Centralized offices, government information services, state or Federal

5. Specific services that could be of interest

   a. Referral (specify type)

   b. Seminars, workshop, etc.

   c. Marketing

      1. Marketing surveys on new products

      2. Subcontract, licensing, etc.

   d. Other management science information

Questions for personal interviews continued:

5. e. Information retrieval, NASA file

    1. Speed of answer required

    2. Number of questions

    3. To find relevant sources of R&D

   f. Other management science information

6. In what ways do you feel federally funded R&D is relevant to your company?

   a. Contracts from federal agency or federal contractor

   b. New products

   c. General stimulation of thinking in new areas

7. Possible problem areas of working with an RDC

   a. Trade secrets

   b. Other company proprietary information

   c. Communication

8. What experience if any have you had in working with a Government agency?

   a. Federal

   b. State

   c. Municipal

9. What role should the Federal government play in assisting local government and business in applying new technology to the solution of public needs such as urban redevelopment?

Exhibit V

SIC NUMBER	NO. of FIRMS	DESCRIPTION
2086	1	Bottled and canned soft drinks and carbonated waters.
2231	1	Broad woven fabric mills, wool: including dyeing and finishing.
2241	1	Narrow fabrics and other smallwares mills: cotton, wool, silk and man-made fiber.
2256	1	Knit fabric mills.
2431	1	Millwork plants.
2499	1	Wood products, not elsewhere classified.
2512	1	Wood household furniture, upholstered.
2621	1	Paper mills, except building paper mills.
2821	2	Plastics materials, synthetic resins, and nonvulcanizable elastomers.
2834	3	Pharmaceutical preparations.
2841	1	Soap and other detergents, except specialty cleaners.
2842	2	Specialty cleaning, polishing, and sanitation preparation, except soap and detergents.
2844	1	Perfumes, cosmetics, and other toilet preparation.
2851	2	Paints, varnishes, lacquers, and enamels.
3069	2	Fabricated rubber products, not elsewhere classified.
3079	3	Miscellaneous plastics products.
3111	2	Leather tanning and finishing.
3131	2	Boot and shoe cut stock and findings.
3141	4	Footwear, except house slippers and rubber footwear.
3272	1	Concrete products, except block and brick.
3357	1	Drawing and insulating of nonferrous wire.
3361	2	Aluminum castings.

SIC NUMBER	NO. OF FIRMS	DESCRIPTION
3362	1	Brass, bronze, copper, copper base alloy castings.
3391	1	Iron and steel forgings.
3423	1	Hand and dege tools, except machine tools and hand saws.
3429	1	Hardware, not elsewhere classified.
3441	1	Fabricated structural steel
3451	1	Screw machine products.
3452	1	Bolts, nuts, screws, rivets and washers.
3461	1	Metal stamping.
3471	2	Electroplating, plating, polishing, anodizing and coloring.
3479	2	Coating, engraving, and allied services, not elsewhere classified.
3494	3	Valves and pipe fittings, except plumbbers' brass goods.
3499	3	Fabricated metal products, not elsewhere classified.
3541	1	Machine tools, metal cutting types.
3544	1	Special dies and tools, die sets, jigs and fixtures.
3552	1	Textile machinery.
3559	3	Special industry machinery, not elsewhere classified.
3571	4	Computing and accounting machines, including cash registers.
3585	1	Refrigerators; refrigeration machinery, except household; and complete air conditioning units.
3591	2	Machine shops, jobbing and repair.
3629	1	Electrical industrial apparatus, not elsewhere classified.
3662	2	Radio and television transmitting, signaling, and detection equipment and apparatus.

SIC NUMBER	NO. OF FIRMS	DESCRIPTION
3679	2	Electronic components and accessories, not elsewhere classified.
3699	1	Electrical machinery, equipment, and supplies, not elsewhere classified.
3729	2	Aircraft parts and auxiliary equipment, not elsewhere classified.
3811	6	Engineering, laboratory, and scientific and research instruments and associated equipment.
3821	3	Mechanical measuring and controlling instruments, except automatic temperature controls.
3831	1	Optical instruments and lenses.
3842	2	Orthopedic, prosthetic, and surgical appliances and supplies.
3999	1	Manufacturing industries, not elsewhere classified.
7391	4	Research, development, and testing labs. Labs primarily engaged in research, development, and testing on a commercial basis.
8911	1	Engineering and architectural services. Establishments primarily performing services of a professional nature in the fields of engineering and architecture.

EXHIBIT VI

SECTION III **Industrial Listing of Firms**

Industrial Classification of Manufacturing Firms by Four Digit Standard Industrial Classification numbers.

SECTION III

Major Group 19.—ORDNANCE AND ACCESSORIES

Group No.	Industry No.	
191		GUNS, HOWITZERS, MORTARS, AND RELATED EQUIPMENT
	1911	Guns, howitzers, mortars, and related equipment
192		AMMUNITION, EXCEPT FOR SMALL ARMS
	1921	Artillery ammunition
	1922	Ammunition loading and assembling
	1929	Ammunition, not elsewhere classified
193		TANKS AND TANK COMPONENTS
	1931	Tanks and tank components
194		SIGHTING AND FIRE CONTROL EQUIPMENT
	1941	Sighting and fire control equipment
195		SMALL ARMS
	1951	Small arms
196		SMALL ARMS AMMUNITION
	1961	Small arms ammunition
199		ORDNANCE AND ACCESSORIES, NOT ELSE-WHERE CLASSIFIED.
	1999	Ordnance and accessories, not elsewhere classified

Major Group 20.—FOOD AND KINDRED PRODUCTS

Group No.	Industry No.	
201		MEAT PRODUCTS
	2011	Meat Packing Plants
	2013	Sausages and other prepared meat products
	2015	Poultry and small game dressing and packing, wholesale
202		DAIRY PRODUCTS
	2021	Creamery butter
	2022	Natural Cheese
	2023	Condensed and evaporated milk
	2024	Ice cream and frozen desserts
	2025	Special dairy products
	2026	Fluid milk
203		CANNING AND PRESERVING FRUITS, VEGETABLES, AND SEA FOODS
	2031	Canned and cured sea foods
	2032	Canned specialties
	2033	Canned fruits, vegetables, preserves, jams, and jellies
	2034	Dried and dehydrated fruits and vegetables
	2035	Pickled fruits and vegetables; vegetable sauces and seasonings; salad dressings
	2036	Fresh or frozen packaged fish
	2037	Frozen fruits, fruit juices, vegetables, and specialties
204		GRAIN MILL PRODUCTS
	2041	Flour and other grain mill products
	2042	Prepared feeds for animals and fowls
	2043	Cereal preparations
	2044	Rice milling
	2045	Blended and prepared flour
	2046	Wet corn milling
205		BAKERY PRODUCTS
	2051	Bread and other bakery products, except biscuit, crackers, and pretzels
	2052	Biscuit, crackers, and pretzels
206		SUGAR
	2061	Cane sugar, except refining only
	2062	Cane sugar refining
	2063	Beet sugar
207		CONFECTIONERY AND RELATED PRODUCTS
	2071	Candy and other confectionery products
	2072	Chocolate and cocoa products
	2073	Chewing gum
208		BEVERAGE INDUSTRIES
	2082	Malt liquors
	2083	Malt
	2084	Wines, brandy, and brandy spirits
	2085	Distilled, rectified, and blended liquors
	2086	Bottled and canned soft drinks and carbonated waters.
	2087	Flavoring extracts and flavoring sirups, not elsewhere classified
209		MISCELLANEOUS FOOD PREPARATIONS AND KINDRED PRODUCTS
	2091	Cottonseed oil mills
	2092	Soybean oil mills
	2093	Vegetable oil mills, except cottonseed and soybean
	2094	Grease and tallow
	2095	Animal and marine fats and oils, except grease and tallow
	2096	Shortening, table oils, margarine and other edible fats and oils, not elsewhere classified
	2097	Manufactured ice
	2098	Macaroni, spaghetti, vermicelli, and noodles
	2099	Food preparations, not elsewhere classified

Major Group 21.—TOBACCO MANUFACTURES

Group No.	Industry No.	
211		CIGARETTES
	2111	Cigarettes
212		CIGARS
	2121	Cigars
213		TOBACCO (CHEWING AND SMOKING) AND SNUFF
	2131	Tobacco (chewing and smoking) and snuff
214		TOBACCO STEMMING AND REDRYING
	2141	Tobacco stemming and redrying

Group No.	Industry No.	
		Major Group 22.—TEXTILE MILL PRODUCTS
221		BROAD WOVEN FABRIC MILLS, COTTON
	2211	Broad woven fabric mills, cotton
222		BROAD WOVEN FABRIC MILLS, MAN-MADE FIBER AND SILK
	2221	Broad woven fabric mills, man-made fiber and silk
223		BROAD WOVEN FABRIC MILLS, WOOL: INCLUDING DYEING AND FINISHING
	2231	Broad woven fabric mills, wool: including dyeing and finishing
224		NARROW FABRICS AND OTHER SMALLWARES MILLS: COTTON, WOOL, SILK, AND MAN-MADE FIBER
	2241	Narrow fabrics and other smallwares mills: cotton, wool, silk and man-made fiber
225		KNITTING MILLS
	2251	Full-fashioned hosiery mills
	2252	Seamless hosiery mills
	2253	Knit outerwear mills
	2254	Knit underwear mills
	2256	Knit fabric mills
	2259	Knitting mills, not elsewhere classified
226		DYEING AND FINISHING TEXTILES, EXCEPT WOOL, FABRICS AND KNIT GOODS
	2261	Finishers of broad woven fabrics of cotton
	2262	Finishers of broad woven fabrics of man-made fiber and silk
	2269	Dyeing and finishing textiles, not elsewhere classified
227		FLOOR COVERING MILLS
	2271	Woven carpets and rugs
	2272	Tufted carpets and rugs
	2279	Carpets, rugs, and mats, not elsewhere classied
228		YARN AND THREAD MILLS
	2281	Yarn spinning mills, cotton, man-made fibers and silk
	2282	Yarn throwing, twisting, and winding mills, cotton, man-made fibers and silk
	2283	Yarn mills, wool, including carpet and rug yarn
	2284	Thread mills
229		MISCELLANEOUS TEXTILE GOODS
	2291	Felt goods, except woven felts and hats
	2292	Lace goods
	2293	Paddings and upholstery filling
	2294	Processed waste and recovered fibers and flock
	2295	Artificial leather, oilcloth, and other impregnated and coated fabrics except rubberized
	2296	Tire cord and fabric
	2297	Wool scouring, worsted combing, and tow to top mills
	2298	Cordage and twine
	2299	Textile goods, not elsewhere classified
		Major Group 23.—APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS AND SIMILAR MATERIALS
231		MEN'S, YOUTHS', AND BOYS' SUITS, COATS, AND OVERCOATS
	2311	Men's, youths', and boys' suits, coats and overcoats
232		MEN'S, YOUTHS', AND BOYS' FURNISHINGS, WORK CLOTHING, AND ALLIED GARMENTS
	2321	Men's, youths', and boys' shirts (except work shirts), collars, and nightwear
	2322	Men's, youths', and boys' underwear
	2323	Men's, youths', and boys' neckwear
	2327	Men's, youths', and boys' separate trousers
	2328	Work clothing
	2329	Men's youths', and boys' clothing, not elsewhere classified
233		WOMEN'S MISSES', AND JUNIORS' OUTERWEAR
	2331	Blouses, waists, and shirts
	2335	Dresses
	2337	Suits, skirts, and coats, except fur coats and raincoats
	2339	Women's, misses', and juniors' outerwear, not elsewhere classified
234		WOMEN'S, MISSES', CHILDREN'S, AND INFANTS' UNDER GARMENTS
	2341	Women's, misses', children's and infants' underwear and nightwear
	2342	Corsets and allied garments
235		HATS, CAPS, AND MILLINERY
	2351	Millinery
	2352	Men's and boys' hats and caps
236		GIRLS', CHILDREN'S, AND INFANTS' OUTERWEAR
	2361	Dresses, blouses, waists, and shirts
	2363	Coats and suits
	2369	Girls', children's and infants' outerwear, not elsewhere classified
237		FUR GOODS
	2371	Fur goods
238		MISCELLANEOUS APPAREL AND ACCESSORIES
	2381	Dress and work gloves, except knit and all leather
	2384	Robes and dressing gowns
	2385	Raincoats and other waterproof outer garments
	2386	Leather and sheep lined clothing
	2387	Apparel belts
	2389	Apparel, not elsewhere classified

Group No.	Industry No.	
239		MISCELLANEOUS FABRICATED TEXTILE PRODUCTS
	2391	Curtains and draperies
	2392	Housefurnishings, except curtains and draperies.
	2393	Textile bags
	2394	Canvas products
	2395	Pleating, decorative and novelty stitching, and tucking for the trade
	2396	Apparel findings and related products
	2397	Schiffli machine embroideries
	2399	Fabricated textile products, not elsewhere classified

Major Group 24.—LUMBER AND WOOD PRODUCTS, EXCEPT FURNITURE

Group No.	Industry No.	
241		LOGGING CAMPS AND LOGGING CONTRACTORS
	2411	Logging camps and logging contractors
242		SAWMILLS AND PLANING MILLS
	2421	Sawmills and planing mills, general
	2426	Hardwood dimension and flooring mills
	2429	Special product sawmills, not elsewhere classified
243		MILLWORK, VENEER, PLYWOOD, AND PREFABRICATED STRUCTURAL WOOD PRODUCTS
	2431	Millwork plants
	2432	Veneer and plywood plants.
	2433	Prefabricated wooden buildings and structural members.
244		WOODEN CONTAINERS
	2441	Nailed and lock corner wooden boxes and shook
	2442	Wirebound boxes and crates
	2443	Veneer and plywood containers, except boxes and crates
	2445	Cooperage
249		MISCELLANEOUS WOOD PRODUCTS
	2491	Wood preserving
	2499	Wood products, not elsewhere classified

Major Group 25.—FURNITURE AND FIXTURES

Group No.	Industry No.	
251		HOUSEHOLD FURNITURE
	2511	Wood household furniture, except upholstered
	2512	Wood household furniture, upholstered
	2514	Metal household furniture
	2515	Mattresses and bedsprings
	2519	Household furniture, not elsewhere classified
252		OFFICE FURNITURE
	2521	Wood office furniture
	2522	Metal office furniture
253		PUBLIC BUILDING AND RELATED FURNITURE
	2531	Public building and related furniture
254		PARTITIONS, SHELVING, LOCKERS, AND OFFICE AND STORE FIXTURES
	2541	Wood partitions, shelving, lockers, and office and store fixtures
	2542	Metal partitions, shelving, lockers, and office and store fixtures
259		MISCELLANEOUS FURNITURE AND FIXTURES
	2591	Venetian blinds and shades
	2599	Furniture and fixtures, not elsewhere classified

Major Group 26.—PAPER AND ALLIED PRODUCTS

Group No.	Industry No.	
261		PULP MILLS
	2611	Pulp mills
262		PAPER MILLS, EXCEPT BUILDING PAPER MILLS
	2621	Paper mills, except building paper mills
263		PAPERBOARD MILLS
	2631	Paperboard mills
264		CONVERTED PAPER AND PAPERBOARD PRODUCTS, EXCEPT CONTAINERS AND BOXES
	2641	Paper coating and glazing
	2642	Envelopes
	2643	Bags, except textile bags
	2644	Wallpaper
	2645	Die cut paper and paperboard; and cardboard
	2646	Pressed and molded pulp goods.
	2649	Converted paper and paperboard products, not elsewhere classified
265		PAPERBOARD CONTAINERS AND BOXES
	2651	Folding paperboard boxes
	2652	Set-up paperboard boxes
	2653	Corrugated and solid fiber boxes
	2654	Sanitary food containers
	2655	Fiber cans, tubes, drums, and similar products
266		BUILDING PAPER AND BUILDING BOARD MILLS
	2661	Building paper and building board mills

Major Group 27.—PRINTING, PUBLISHING, AND ALLIED INDUSTRIES

Group No.	Industry No.	
271		NEWSPAPERS: PUBLISHING, PUBLISHING AND PRINTING
	2711	Newspapers: publishing, publishing and printing
272		PERIODICALS: PUBLISHING, PUBLISHING AND PRINTING
	2721	Periodicals: publishing, publishing and printing
273		BOOKS
	2731	Books: publishing, publishing and printing
	2732	Book printing

Group No.	Industry No.	
274		MISCELLANEOUS PUBLISHING
	2741	Miscellaneous publishing
275		COMMERCIAL PRINTING
	2751	Commercial printing, except lithographic
	2752	Commercial printing, lithographic
	2753	Engraving and plate printing
276		MANIFOLD BUSINESS FORMS MANUFACTURING
	2761	Manifold business forms manufacturing
277		GREETING CARD MANUFACTURING
	2771	Greeting card manufacturing
278		BOOKBINDING AND RELATED INDUSTRIES
	2782	Blankbooks, loose leaf binders and devices
	2789	Bookbinding, and miscellaneous related work
279		SERVICE INDUSTRIES FOR THE PRINTING TRADE
	2791	Typesetting
	2793	Photoengraving
	2794	Electrotyping and stereotyping
	2799	Service industries for the printing trades, not elsewhere classified

Major Group 28.—CHEMICALS AND ALLIED PRODUCTS

Group No.	Industry No.	
281		INDUSTRIAL INORGANIC AND ORGANIC CHEMICALS
	2812	Alkalies and chlorine
	2813	Industrial gases
	2814	Cyclic (coal tar) crudes
	2815	Dyes, dye (cyclic) intermediates, and organic pigments (lakes and toners)
	2816	Inorganic pigments
	2818	Industrial organic chemicals, not elsewhere classified
	2819	Industrial inorganic chemicals, not elsewhere classified
282		PLASTICS MATERIALS AND SYNTHETIC RESINS, SYNTHETIC RUBBER, SYNTHETIC AND OTHER MAN-MADE FIBERS, EXCEPT GLASS
	2821	Plastics materials, synthetic resins, and nonvulcanizable elastomers
	2822	Synthetic rubber (vulcanizable elastomers)
	2823	Cellulosic man-made fibers
	2824	Synthetic organic fibers, except cellulosic
283		DRUGS
	2831	Biological products
	2833	Medicinal chemicals and botanical products
	2834	Pharmaceutical preparations
284		SOAP, DETERGENTS AND CLEANING PREPARATIONS, PERFUMES, COSMETICS, AND OTHER TOILET PREPARATIONS
	2841	Soap and other detergents, except specialty cleaners
	2842	Specialty cleaning, polishing, and sanitation preparations, except soap and detergents
	2843	Surface active agents, finishing agents, sulfonated oils and assistants
	2844	Perfumes, cosmetics, and other toilet preparations
285		PAINTS, VARNISHES, LACQUERS, ENAMELS, AND ALLIED PRODUCTS
	2851	Paints, varnishes, lacquers, and enamels
	2852	Putty, calking compounds, and allied products
286		GUM AND WOOD CHEMICALS
	2861	Gum and wood chemicals
287		AGRICULTURAL CHEMICALS
	2871	Fertilizers
	2872	Fertilizers, mixing only
	2873	Agricultural pesticides
	2879	Agricultural chemicals, not elsewhere classified
289		MISCELLANEOUS CHEMICAL PRODUCTS
	2891	Glue and gelatin
	2892	Explosives
	2893	Printing ink
	2894	Fatty acids
	2895	Carbon black
	2899	Chemicals and chemical preparations, not elsewhere classified

Major Group 29.—PETROLEUM REFINING AND RELATED INDUSTRIES

Group No.	Industry No.	
291		PETROLEUM REFINING
	2911	Petroleum refining
295		PAVING AND ROOFING MATERIALS
	2951	Paving mixtures and blocks
	2952	Asphalt felts and coatings
299		MISCELLANEOUS PRODUCTS OF PETROLEUM AND COAL
	2992	Lubricating oils and greases
	2999	Products of petroleum and coal, not elsewhere classified

Major Group 30.—RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS

Group No.	Industry No.	
301		TIRES AND INNER TUBES
	3011	Tires and inner tubes
302		RUBBER FOOTWEAR
	3021	Rubber footwear
303		RECLAIMED RUBBER
	3031	Reclaimed rubber
306		FABRICATED RUBBER PRODUCTS, NOT ELSEWHERE CLASSIFIED
	3069	Fabricated rubber products, not elsewhere classified
307		MISCELLANEOUS PLASTICS PRODUCTS
	3079	Miscellaneous plastics products

Group No. | Industry No.

Major Group 31.—LEATHER AND LEATHER PRODUCTS

311 LEATHER TANNING AND FINISHING
- 3111 Leather tanning and finishing.

312 INDUSTRIAL LEATHER BELTING AND PACKING
- 3121 Industrial leather belting and packing

313 BOOT AND SHOE CUT STOCK AND FINDINGS
- 3131 Boot and shoe cut stock and findings

314 FOOTWEAR, EXCEPT RUBBER
- 3141 Footwear, except house slippers and rubber footwear
- 3142 House slippers

315 LEATHER GLOVES AND MITTENS
- 3151 Leather dress, semidress, and work gloves

316 LUGGAGE
- 3161 Luggage

317 HANDBAGS AND OTHER PERSONAL LEATHER GOODS
- 3171 Women's handbags and purses
- 3172 Personal leather goods, except handbags and purses
- 3199 Leather goods, not elsewhere classified

Major Group 32.—STONE, CLAY, AND GLASS PRODUCTS

321 FLAT GLASS
- 3211 Flat glass

322 GLASS AND GLASSWARE, PRESSED OR BLOWN
- 3221 Glass containers
- 3229 Pressed and blown glass and glassware, not elsewhere classified

323 GLASS PRODUCTS, MADE OF PURCHASED GLASS
- 3231 Glass products, made of purchased glass

324 CEMENT, HYDRAULIC
- 3241 Cement, hydraulic

325 STRUCTURAL CLAY PRODUCTS
- 3251 Brick and structural clay tile.
- 3253 Ceramic wall and floor tile
- 3255 Clay refractories
- 3259 Structural clay products, not elsewhere classified

326 POTTERY AND RELATED PRODUCTS
- 3261 Vitreous china plumbing fixtures and china and earthenware fittings and bathroom accessories
- 3262 Vitreous china table and kitchen articles
- 3263 Fine earthenware (Whiteware) table and kitchen articles
- 3264 Porcelain electrical supplies
- 3269 Pottery products, not elsewhere classified

327 CONCRETE, GYPSUM, AND PLASTER PRODUCTS
- 3271 Concrete brick and block
- 3272 Concrete products, except block and brick
- 3273 Ready mixed concrete
- 3274 Lime
- 3275 Gypsum products

328 CUT STONE AND STONE PRODUCTS
- 3281 Cut stone and stone products

329 ABRASIVE, ASBESTOS, AND MISCELLANEOUS NONMETALLIC MINERAL PRODUCTS
- 3291 Abrasive products
- 3292 Asbestos products
- 3293 Steam and other packing, and pipe and boiler covering
- 3295 Minerals and earths, ground or otherwise treated
- 3296 Mineral wool
- 3297 Nonclay refractories
- 3299 Nonmetallic mineral products, not elsewhere classified

Major Group 33.—PRIMARY METAL INDUSTRIES

331 BLAST FURNACES, STEEL WORKS, AND ROLLING AND FINISHING MILLS
- 3312 Blast furnaces (including coke ovens), steel works, and rolling mills
- 3313 Electrometallurgical products
- 3315 Steel wire drawing and steel nails and spikes
- 3316 Cold rolled sheet, strip, and bars
- 3317 Steel pipe and tubes

332 IRON AND STEEL FOUNDRIES
- 3321 Gray iron foundries
- 3322 Malleable iron foundries
- 3323 Steel foundries

333 PRIMARY SMELTING AND REFINING OF NONFERROUS METALS
- 3331 Primary smelting and refining of copper
- 3332 Primary smelting and refining of lead
- 3333 Primary smelting and refining of zinc
- 3334 Primary production of aluminum
- 3339 Primary smelting and refining of nonferrous metals, not elsewhere classified

334 SECONDARY SMELTING AND REFINING OF NONFERROUS METALS AND ALLOYS
- 3341 Secondary smelting, refining, and alloying of nonferrous metals and alloys

335 ROLLING, DRAWING AND EXTRUDING OF NONFERROUS METALS
- 3351 Rolling, drawing, and extruding of copper
- 3352 Rolling, drawing, and extruding of aluminum
- 3356 Rolling, drawing, and extruding of nonferrous metals, except copper and aluminum
- 3357 Drawing and insulating of nonferrous wire

Group No.	Industry No.	
336		NONFERROUS FOUNDRIES
	3361	Aluminum castings
	3362	Brass, bronze, copper, copper base alloy castings
	3369	Nonferrous castings, not elsewhere classified
339		MISCELLANEOUS PRIMARY METAL INDUSTRIES
	3391	Iron and steel forgings
	3392	Nonferrous forgings
	3399	Primary metal industries, not elsewhere classified

Major Group 34.—FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, AND TRANSPORTATION EQUIPMENT

Group No.	Industry No.	
341		METAL CANS
	3411	Metal cans
342		CUTLERY, HAND TOOLS, AND GENERAL HARDWARE
	3421	Cutlery
	3423	Hand and edge tools, except machine tools and hand saws
	3425	Hand saws and saw blades
	3429	Hardware, not elsewhere classified
343		HEATING APPARATUS (EXCEPT ELECTRIC) AND PLUMBING FIXTURES
	3431	Enameled iron and metal sanitary ware
	3432	Plumbing fixture fittings and trim (brass goods)
	3433	Heating equipment, except electric
344		FABRICATED STRUCTURAL METAL PRODUCTS
	3441	Fabricated structural steel
	3442	Metal doors, sash, frames, molding, and trim
	3443	Fabricated plate work (boiler shops)
	3444	Sheet metal work
	3449	Architectural and miscellaneous metal work
345		SCREW MACHINE PRODUCTS, AND BOLTS, NUTS, SCREWS, RIVETS AND WASHERS
	3451	Screw machine products
	3452	Bolts, nuts, screws, rivets and washers
346		METAL STAMPINGS
	3461	Metal stampings
347		COATING, ENGRAVING, AND ALLIED SERVICES
	3471	Electroplating, plating, polishing, anodizing and coloring
	3479	Coating, engraving, and allied services, not elsewhere classified
348		MISCELLANEOUS FABRICATED WIRE PRODUCTS
	3481	Miscellaneous fabricated wire products
349		MISCELLANEOUS FABRICATED METAL PRODUCTS
	3491	Metal shipping barrels, drums, kegs, and pails
	3492	Safes and vaults
	3493	Steel springs
	3494	Valves and pipe fittings, except plumbers' brass goods
	3496	Collapsible tubes
	3497	Metal foil and leaf
	3498	Fabricated pipe and fabricated pipe fittings
	3499	Fabricated metal products, not elsewhere classified

Major Group 35.—MACHINERY, EXCEPT ELECTRICAL

Group No.	Industry No.	
351		ENGINES AND TURBINES
	3511	Steam engines; steam, gas, and hydraulic turbines; and steam, gas, and hydraulic turbine generator set units
	3519	Internal combustion engines, not elsewhere classified
352		FARM MACHINERY AND EQUIPMENT
	3522	Farm machinery and equipment
353		CONSTRUCTION, MINING, AND MATERIALS HANDLING MACHINERY AND EQUIPMENT
	3531	Construction machinery and equipment
	3532	Mining machinery and equipment, except oil field machinery and equipment
	3533	Oil field machinery and equipment
	3534	Elevators and moving stairways
	3535	Conveyors and conveying equipment
	3536	Hoists, industrial cranes, and monorail systems
	3537	Industrial trucks, tractors, trailers, and stackers
354		METAL WORKING MACHINERY AND EQUIPMENT
	3541	Machine tools, metal cutting types
	3542	Machine tools, metal forming types
	3544	Special dies and tools, die sets, jigs and fixtures
	3545	Machine tool accessories and measuring devices
	3548	Metalworking machinery, except machine tools
355		SPECIAL INDUSTRY MACHINERY, EXCEPT METALWORKING MACHINERY
	3551	Food products machinery
	3552	Textile machinery
	3553	Woodworking machinery
	3554	Paper industries machinery
	3555	Printing trades machinery and equipment
	3559	Special industry machinery, not elsewhere classified
356		GENERAL INDUSTRIAL MACHINERY AND EQUIPMENT
	3561	Pumps, air and gas compressors, and pumping equipment

Group No.	Industry No.	
	3562	Ball and roller bearings
	3564	Blowers, exhaust and ventilating fans
	3565	Industrial patterns
	3566	Mechanical power transmission equipment, except ball and roller bearings
	3567	Industrial process furnaces and ovens
	3569	General industrial machinery and equipment, not elsewhere classified.
357		OFFICE, COMPUTING, AND ACCOUNTING MACHINES
	3571	Computing and accounting machines, including cash registers
	3572	Typewriters
	3576	Scales and balances, except laboratory
	3579	Office machines, not elsewhere classified
358		SERVICE INDUSTRY MACHINES
	3581	Automatic merchandising machines
	3582	Commercial laundry, dry cleaning, and pressing machines
	3584	Vacuum cleaners, industrial
	3585	Refrigerators; refrigeration machinery, except household; and complete air conditioning units
	3586	Measuring and dispensing pumps
	3589	Service industry machines, not elsewhere classified
359		MISCELLANEOUS MACHINERY, EXCEPT ELECTRICAL
	3591	Machine shops, jobbing and repair
	3599	Machinery and parts, except electrical, not elsewhere classified

Major Group 36.—ELECTRICAL MACHINERY, EQUIPMENT, AND SUPPLIES

Group No.	Industry No.	
361		ELECTRIC TRANSMISSION AND DISTRIBUTION EQUIPMENT
	3611	Electric measuring instruments and test equipment
	3612	Power, distribution, and specialty transformers
	3613	Switchgear and switchboard apparatus
	3619	Electric transmission and distribution equipment, not elsewhere classified
362		ELECTRICAL INDUSTRIAL APPARATUS
	3621	Motors and generators
	3622	Industrial controls
	3623	Welding apparatus
	3624	Carbon and graphite products
	3629	Electrical industrial apparatus, not elsewhere classified
363		HOUSEHOLD APPLIANCES
	3631	Household cooking equipment
	3632	Household refrigerators and home and farm freezers
	3633	Household laundry equipment
	3634	Electric housewares and fans
	3635	Household vacuum cleaners
	3636	Sewing machines
	3639	Household appliances, not elsewhere classified
364		ELECTRIC LIGHTING AND WIRING EQUIPMENT
	3641	Electric lamps
	3642	Lighting fixtures
	3643	Current carrying wiring devices
	3644	Noncurrent carrying wiring devices
365		RADIO AND TELEVISION RECEIVING SETS, EXCEPT COMMUNICATIONS TYPES
	3651	Radio and television receiving sets, except communication types
	3652	Phonograph records
366		COMMUNICATION EQUIPMENT
	3661	Telephone and telegraph apparatus
	3662	Radio and television transmitting, signaling, and detection equipment and apparatus
367		ELECTRONIC COMPONENTS AND ACCESSORIES
	3671	Radio and television receiving type electron tubes, except cathode ray
	3672	Cathode ray picture tubes
	3673	Transmitting, industrial, and special purpose electron tubes
	3679	Electronic components and accessories, not elsewhere classified
369		MISCELLANEOUS ELECTRICAL MACHINERY, EQUIPMENT, AND SUPPLIES
	3691	Storage batteries
	3692	Primary batteries, dry and wet
	3693	Radiographic X-ray, fluoroscopic X-ray, therapeutic X-ray, and other X-ray apparatus and tubes
	3694	Electrical equipment for internal combustion engines
	3699	Electrical machinery, equipment, and supplies, not elsewhere classified

Major Group 37.—TRANSPORTATION EQUIPMENT

Group No.	Industry No.	
371		MOTOR VEHICLES AND MOTOR VEHICLE EQUIPMENT
	3711	Motor vehicles
	3712	Passenger car bodies
	3713	Truck and bus bodies
	3714	Motor vehicle parts and accessories
	3715	Truck trailers
372		AIRCRAFT AND PARTS
	3721	Aircraft
	3722	Aircraft engines and engine parts
	3723	Aircraft propellers and propeller parts
	3729	Aircraft parts and auxiliary equipment, not elsewhere classified
373		SHIP AND BOAT BUILDING AND REPAIRING
	3731	Ship building and repairing
	3732	Boat building and repairing
374		RAILROAD EQUIPMENT
	3741	Locomotives and parts
	3742	Railroad and street cars

Group No.	Industrial No.	
375		MOTORCYCLES, BICYCLES, AND PARTS
	3751	Motorcycles, bicycles, and parts
379		MISCELLANEOUS TRANSPORTATION EQUIPMENT
	3791	Trailer coaches
	3799	Transportation equipment, not elsewhere classified

Major Group 38.—PROFESSIONAL, SCIENTIFIC, AND CONTROLLING INSTRUMENTS: PHOTOGRAPHIC AND OPTICAL GOODS: WATCHES AND CLOCKS

Group No.	Industrial No.	
381		ENGINEERING, LABORATORY AND SCIENTIFIC AND RESEARCH INSTRUMENTS AND ASSOCIATED EQUIPMENT
	3811	Engineering, laboratory, and scientific and research instruments and associated equipment
382		INSTRUMENTS FOR MEASURING, CONTROLLING, AND INDICATING PHYSICAL CHARACTERISTICS
	3821	Mechanical measuring and controlling instruments, except automatic temperature controls
	3822	Automatic temperature controls
383		OPTICAL INSTRUMENTS AND LENSES
	3831	Optical instruments and lenses
384		SURGICAL, MEDICAL, AND DENTAL INSTRUMENTS AND SUPPLIES
	3841	Surgical and medical instruments and apparatus
	3842	Orthopedic, prosthetic, and surgical appliances and supplies
	3843	Dental equipment and supplies
385		OPHTHALMIC GOODS
	3851	Ophthalmic goods
386		PHOTOGRAPHIC EQUIPMENT AND SUPPLIES
	3861	Photographic equipment and supplies
387		WATCHES, CLOCKS, CLOCKWORK OPERATED DEVICES, AND PARTS
	3871	Watches, clocks, and parts except watchcases
	3872	Watchcases

Major Group 39.—MISCELLANEOUS MANUFACTURING INDUSTRIES

Group No.	Industrial No.	
391		JEWELRY, SILVERWARE, AND PLATED WARE
	3911	Jewelry, precious metal
	3912	Jewelers' findings and materials
	3913	Lapidary work and cutting and polishing diamonds
	3914	Silverware and plated ware
393		MUSICAL INSTRUMENTS AND PARTS
	3931	Musical instruments and parts
394		TOYS, AMUSEMENT, SPORTING AND ATHLETIC GOODS
	3941	Games and toys, except dolls and children's vehicles
	3942	Dolls
	3943	Children's vehicles, except bicycles
	3949	Sporting and athletic goods, not elsewhere classified
395		PENS, PENCILS, AND OTHER OFFICE AND ARTISTS' MATERIALS
	3951	Pens, pen points, fountain pens, ball point pens, mechanical pencils and parts
	3952	Lead pencils, crayons, and artists' materials
	3953	Marking devices
	3955	Carbon paper and inked ribbons
396		COSTUME JEWELRY, COSTUME NOVELTIES, BUTTONS, AND MISCELLANEOUS NOTIONS, EXCEPT PRECIOUS METAL
	3961	Costume jewelry and costume novelties, except precious metal
	3962	Feathers, plumes, and artificial flowers
	3963	Buttons
	3964	Needles, pins, hooks and eyes, and similar notions
398-399		MISCELLANEOUS MANUFACTURING INDUSTRIES
	3981	Brooms and brushes
	3982	Linoleum, asphalted-felt-base, and other hard surface floor coverings, not elsewhere classified
	3983	Matches
	3984	Candles
	3987	Lamp shades
	3988	Morticians' goods
	3992	Furs, dressed and dyed
	3993	Signs and advertising displays
	3995	Umbrellas, parasols, and canes
	3999	Manufacturing industries, not elsewhere classified

APPENDIX B

Subject: Evaluation of and proposal for leasing a computer at a proposed New England RDC.

By: Dr. Daniel U. Wilde

The following is a discussion of reasons why the proposed New England Research Application Center should obtain its own in-house digital computer. The discussion first reviews the steps that led to the above conclusion and then it elaborates on two advantages of that conclusion.

A. REVIEW OF THE COMPUTER INVESTIGATION PROCEDURE

During the past six months, I have been studying and evaluating the NASA information retrieval and dissemination system. This work was divided into three sequential steps: review and evaluation of existing NASA systems; theorization and experimentation with new systems; and evaluation of effects of these new systems on NERAC operations and the NERAC environment.

1. Review and Evaluation of Existing NASA Systems

The first two months of the NERAC feasibility study were spent learning the details of the NASA system at the Washington Facility and understanding the adaptations of the system by other existing university dissemination centers. Because the NASA operation at the Wasington Facility is so large and complex, we have no choice but to use their system output as our system input, i.e. the NASA magnetic tape file. This leaves us the same choice that was left to other university centers - how do we adapt the NASA system to fit our own requirements.

At the suggestion of NASA, we visited several existing university centers to see their operation at first hand. At these centers we found a broad range of computer applications. Not only was there a difference in their computer utilization level but also in their sophistication level. From these two differences we concluded that, because the NASA file is so large, one must use the computer in some "better" way or else computer searches will surely prove too costly.

2. Theorization and Experimentation with New Systems

The next four months of the study were comsumed in developing a new retrieval system in hopes of coming up with that "better" procedure. We then knew that if our work load projections were valid and if we used one of the existing retrieval systems for all our retrievals, we could expect computer costs to average $20,000 to $30,000 a month. Thus, we had to find that "better" procedure or else abandon our plans for a computerized operation.

Because an order of magnitude improvement was found, the proposed center is faced with computer costs of around $2,000 to $3,000 a month for the same computerized retrieval work. But may I also now point out that up to now our goal was only - <u>minimize computer costs without sacrificing computerization of retrievals</u>.

3. The Effect of Our "Better" Procedure on RDC Operations and the RDC Environment

The first outright effect of our "better" procedure on the proposed RDC operations was that it could choose to perform all its searches by machine and yet do it at a reasonable cost. But as we began to study our man-machine system interfaces, we discovered that not only were we attempting to minimize computer costs but also we were employing a negative computer utilization philosophy. If we had automated our retrieving operations, it was logical that we should consider automating the many ancillary functions, such as managerial control, statistical analysis, and repetative typing and mailing.

At about this time Mr. Van Wente, our NASA computer advisor, sent me a review article by I. A. Warheit[1] which stated that all existing computerized retrieval systems operated under one great restriction, i.e. "the necessary functions of storing, retrieving and processing were not carried out when the need arose but were dictated by the computer schedule and operating mode....A service that is not able to respond when it is needed will not be used very much....All computer systems operate essentially on a scheduled basis but the need for information services are often unscheduled and frequently urgent.

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[1] I.A. Warheit, "The Combined File Search System, A Case Study of System Design For Information Retrieval," 1965 FID Congress, Washington, D.C.

B. THE EFFECTS OF AN IN-HOUSE COMPUTER

A comparison of the advantages and disadvantages of more utilization of the University Computation Center versus an in-house computer can be made in two major areas. First, what are the cost comparisons between an in-house computer and the University Computation Center. Second, what are the effects of an in-house computer on RDC's internal operations.

1. Cost Comparisons

For each hour of time used at the University Computation Center, the RDC pays X dollars per hour. On the other hand if the RDC has its own machine, it pays a fixed Y dollars per month. If the RDC uses N hours of computer time at the Computation Center each month, the in-house machine becomes cheaper as soon Y is less than N times X.

Figure One shows a comparison of projected monthly computer costs. The "Minimized Computation Center Rate" curve shows the monthly cost of performing only the minimum projected retrieval searches at the University Computation Center. The output of such searches would only be accession numbers and would not contain any helpful information, such as "notation of content" and "English vocabulary terms." To obtain such information would mean <u>more than doubling</u> the search costs. In addition the minimized curve does not include costs associated with such required items as routine statistical analysis of search results for search improvement or further research into information retrieval techniques via computer. The initial peak in the "Minimized" curve is due to the estimated high cost of the first conversion of the complete NASA linear file to the proposed RDC format.

The "1401" curve shows the monthly cost of renting the minimal 1401 configuration which will satisfactorily perform the searches. (This minimum configuration has been tested and evaluated by converting previously mentioned FORTRAN search and reformat programs to 1401 assembly language.) The initial spike in the 1401 curve is due to a $500.00 power installation charge while the second drop occurs because of a rental reduction during mid - summer of 1967.

Figure One indicates that the in-house machine is cheaper just after twelve months even though it provides more useful output. Figure Two shows the projected breakeven points between the two systems by comparing total dollars spent as a function of month. The graph indicates equal total cost at around twenty-one months. It must be remembered that if the proposed RDC were to maximize the use of the Computation Center, its associated costs would more than double and the in-house machine would be cheaper from the very beginning.

2. The Effects On the Proposed RDC Internal Operations

Without going into detail, may I now summarize how an in-house computer will effect the proposed RDC internal operation.

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2. The Effects On the Proposed RDC Internal Operations

Without going into detail, may I now summarize how an in-house computer will effect the proposed RDC internal operation.

a. The computational source could be scheduled to perform its work to meet the proposed RDC's priority schedule.

b. The computational source could also be scheduled to conform to the schedules and work loads of both our technical and applications specialists.

c. The computational source would be available for evening, midnight, and weekend use by the RDC staff for uninterrupted research and debugging work.

d. The in-house source would permit an in-house cost reduction program. This should prove very significant from an overall RDC breakeven standpoint.

e. The computer would be in the same room as the rest of the operations staff. With all operations in the same room, there would be no hand carrying of cards, tapes, printouts, or bibliographic material from one building to another.

f. The in-house computer would produce quicker one-shot, special history searches. Because the search results would start coming out of the computer almost immediately, the initial results could be checked immediately. If the results did not look "good", the search question could be changed and the run restarted. Thus, less human time would be wasted, and the search results would be produced in less elapsed time.

g. With an in-house computer, the proposed RDC can take advantage of the "notation of content" (NOC) portion of each document tape entry. The NOC is a brief abstract and can be used as an abstract substitute. This substitution can replace the NASA supplied paper abstract if NASA stops supplying such abstracts at a later date. In addition, the NOC can be used internally rather than a costly duplicate of the abstract. If the NOC were used at the Computation Center, the run time and cost would more than double and the output printing would go up by ten. This would not produce a significant cost increase with an in-house computer and would permit notable paper reproduction cost savings by reducing XEROX charges.

h. With an in-house computer, the RDC operations would not be effected by Computation Center computer changes. For example, when the new 360/65 arrives, the RDC will be without a computational source for at least six weeks. Also, with an in-house system the RDC would not be effected by 360/65 downtime due to a new system shakedown on the part of the Computation Center and local IBM staffs.

i. With all retrieval searches being performed in-house, the operational conditions can be completely controlled. This will permit the RDC to detect operational characteristics and to produce valid statistics as a function of different operational conditions.

j. An in-house computer will permit the RDC to perform generalized bibliographic searches with very little burden on the staff.

k. At least once a year, the RDC can expect to receive a tape with undetected errors. When this happens, the RDC must either send the tape back to Washington and wait at least one week for a revised tape or a attempt to "patch" the bad tape. Tape patching is complicated and involved and can best be done on a simple machine without rush. An in-house machine would permit us this option.

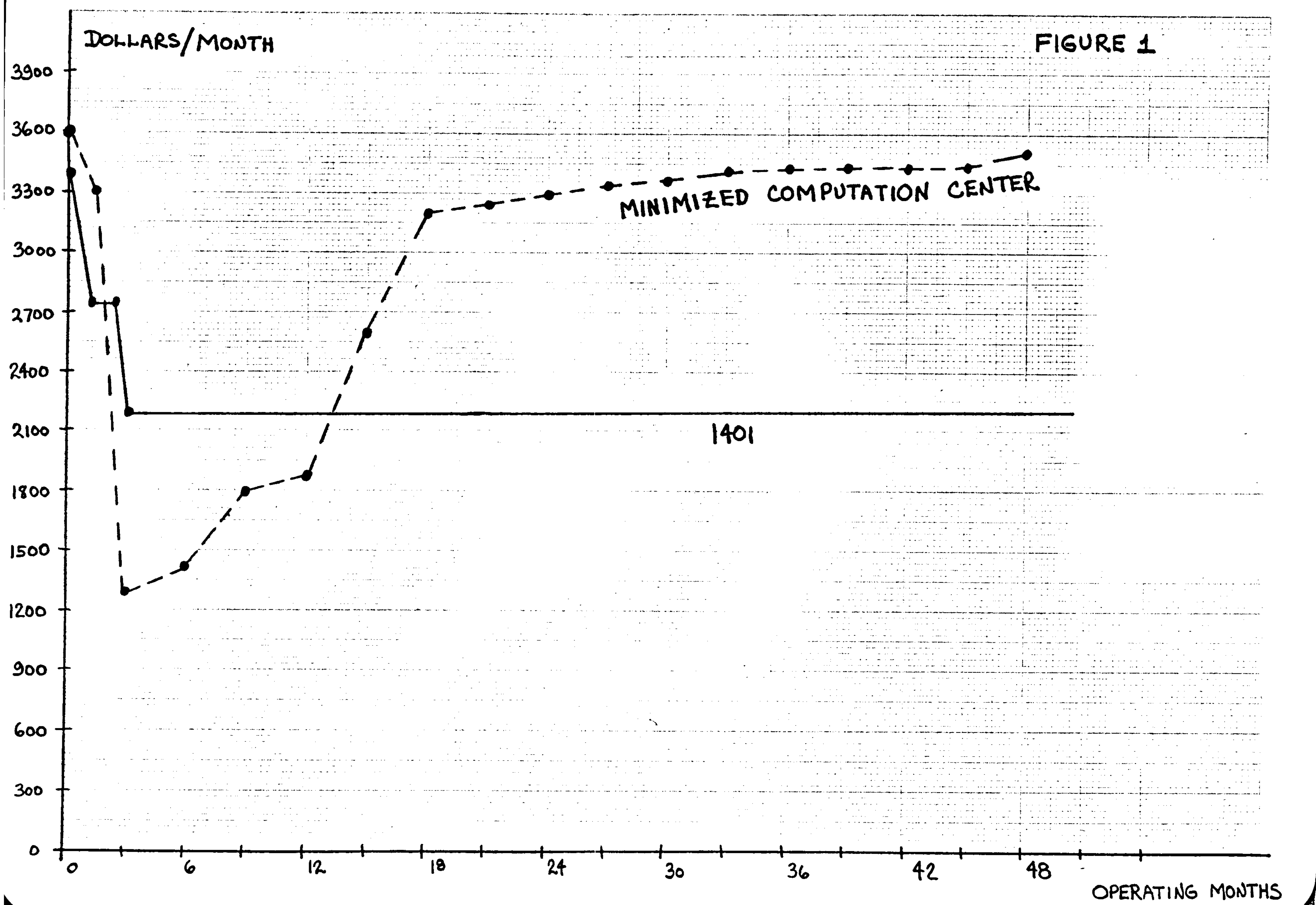
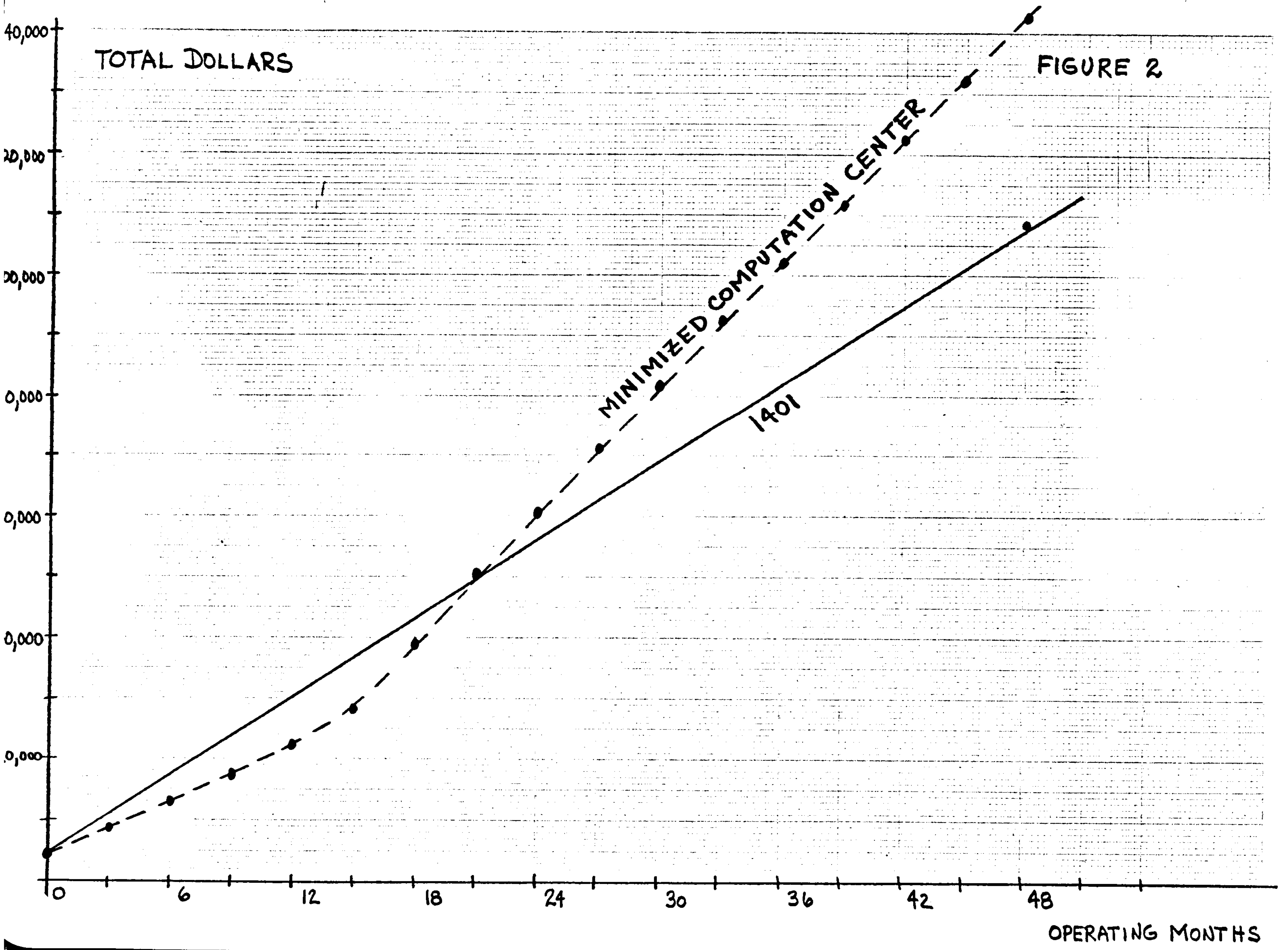

DOLLARS/MONTH
FIGURE 1
3900
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
300
0
MINIMIZED COMPUTATION CENTER
1401
0
6
12
18
24
30
36
42
48
OPERATING MONTHS

EXHIBIT I

The "TAPE TERM COUNT" indicates average number of index terms per accession. The "QUESTION TERM COUNT" denotes average number of terms per question. The "4,000" through "400,000" line indicates the total number of accessions searched on the given retrieval run. The far left-hand column states the number of questions searched on the run. The intersection of any number of questions row and number of accessions column yields two figures. The upper is running time in minutes per question; the lower is cost per question. The two far right-hand columns show the percentage of external processing time, i.e. input or read time, and of internal processing time, i.e. matching tape terms against question terms. These two figures show whether we are input or processing bound.


TOTAL DOLLARS
FIGURE 2
MINIMIZED COMPUTATION CENTER
1401
40,000
0,000
0,000
0,000
0,000
0,000
0,000
0,000
0
6
12
18
24
30
36
42
48
OPERATING MONTHS

APPENDIX C

TAPE TERM COUNT = 17 QUESTION TERM COUNT = 15

NO. QUESTIONS	NO. ACCESSIONS 4,000	5,000	6,000	7,000	200,000	250,000	300,000	350,000	400,000	EP	IP
1	1.353 $2.48	1.692 $3.10	2.030 $3.72	2.368 $4.34	67.668 $124.06	84.585 $155.07	101.502 $186.09	118.418 $217.10	135.335 $248.11	0.61	0.39
2	0.804 $1.47	1.006 $1.84	1.207 $2.21	1.408 $2.58	40.223 $ 73.74	50.278 $ 92.18	60.334 $110.61	70.390 $129.05	80.445 $147.48	0.52	0.48
3	0.618 $1.13	0.772 $1.42	0.927 $1.70	1.081 $1.98	30.889 $ 56.63	38.612 $ 70.79	46.334 $ 84.95	54.056 $ 99.10	61.778 $113.26	0.45	0.55
4	0.524 $0.96	0.656 $1.20	0.787 $1.44	0.918 $1.68	26.222 $ 48.07	32.778 $ 60.09	39.334 $ 72.11	45.889 $ 84.13	52.445 $ 96.15	0.40	0.60
5	0.468 $0.86	0.586 $1.07	0.703 $1.29	0.820 $1.50	23.422 $ 42.94	29.278 $ 53.68	35.134 $ 64.41	40.989 $ 75.15	46.845 $ 85.88	0.35	0.65
10	0.359 $0.66	0.448 $0.82	0.538 $0.99	0.628 $1.15	17.933 $ 32.88	22.417 $ 41.10	26.900 $ 49.32	31.384 $ 57.54	35.867 $ 65.76	0.23	0.77
20	0.303 $0.56	0.379 $0.69	0.455 $0.83	0.531 $0.97	15.161 $ 27.80	18.951 $ 34.74	22.742 $ 41.69	26.532 $ 48.64	30.322 $ 55.59	0.14	0.86
30	0.285 $0.52	0.356 $0.65	0.427 $0.78	0.498 $0.91	14.237 $ 26.10	17.796 $ 32.63	21.356 $ 39.15	24.915 $ 45.68	28.474 $ 52.20	0.10	0.90
40	0.276 $0.51	0.345 $0.63	0.414 $0.76	0.483 $0.88	13.789 $ 25.28	17.236 $ 31.60	20.683 $ 37.92	24.131 $ 44.24	27.578 $ 50.56	0.08	0.92
50	0.270 $0.50	0.338 $0.62	0.405 $0.74	0.473 $0.87	13.509 $ 24.77	16.886 $ 30.96	20.263 $ 37.15	23.641 $ 43.34	27.018 $ 49.53	0.06	0.94
100	0.259 $0.48	0.324 $0.59	0.389 $0.71	0.454 $0.83	12.960 $ 23.76	16.200 $ 29.70	19.440 $ 35.64	22.680 $ 41.58	25.920 $ 47.52	0.03	0.97
150	0.256 $0.47	0.319 $0.59	0.383 $0.70	0.447 $0.82	12.777 $ 23.42	15.971 $ 29.28	19.166 $ 35.14	22.360 $ 40.99	25.554 $ 46.85	0.02	0.98
200	0.254 $0.47	0.317 $0.58	0.381 $0.70	0.444 $0.81	12.688 $ 23.26	15.860 $ 29.08	19.033 $ 34.89	22.205 $ 40.71	25.377 $ 46.52	0.02	0.98

Simulation of NERAC Organizational Structure

Purpose

A simulation of the Center's proposed organizational structure and its operation was undertaken to determine the following:

1. Feasibility of the structure.
2. Efficiency of the structure.
3. Costs of operation.
4. Breakeeven point.
5. Projected manpower and facilities requirements.
6. Justification of pricing structure.
7. Most efficient product mix from cost standpoint.

From the viewpoint of simulating the Center's operation, the core is the information retrieval service. This service, then, has been flowcharted and simulated with provision made in the model for the other services to be performed.

Parameters

Three growth parameters were used as alternatives, and four service mix parameters. Simulated study time in all cases was four years. The growth parameters postulated 100, 200, and 400 client firms at the end of the four year period. Initial condition in all cases was 30 firms. It is to be noted that this latter estimate was conservative, as we now estimate an initial 50 firms.

The service mixes chosen were 2 Standard Profile (SP) firms per Current Awareness (CA) firm: 1 SP firm to 1 CA firm; 1 SP firm to 2 CA firms; and 1 AP firm to 3 CAfirms. Our initial response indicates that the predominance of client firms will use the CA service rather than the SP service. We therefore tested SP:CA ratios of 1:6 and 1:10 for the 200 and 100 firm conditions only, since time did not permit further investigation.

Assumptions and Procedures (Refer to flow chart)

In all cases the initial number of firms was 30 firms. The proportion of the 30 chosen to be SP or CA firms was based on the mix used for that simulation, e.g., if the simulation call for 2 CA firms to every 1 SP firm, then of the initial firms, 20 would be assumed to be CA firms and the other 10 would then be AP firms.

In subsequent months, the number of new firms is determined as follows:

Chart #1 is an estimated growth curve. Three such surves have been generated. One curve assumes the 100 client firms will have joined at the end of a 4-year period, another curve assumes 200 firms at the end of the 4-year period, and the third curve assumes 400 firms at the end of the 4th year.

Chart #2 is a cumulative normal probability curve. It is used in the simulation to transform the regular acquisition of firms as predicted by Chart #1 into a less regular pattern; i.e., one more nearly approximating what would happen in real life. Its use is based on the statistical fact that if each point on Curve #1 is considered to represent the most probable number of firms having joined by Month X, the actual number of firms joining will lie within a normal distribution around that point as a mean.

The procedure for using the two curves is as follows:

1. Enter Chart #1 at the month being simulated. Read the estimated number of firms having joined.

2. Enter Chart #1 at the month prior to that being simulated. Read the estimated number of firms having joined.

3. Subtract the two numbers of firms to determine the estimated number of new firms having joined in the month being simulated.

4. Extract from a table of random digits a two-digit number between 00 and 99. Let this number represent the frequency on the vertical scale of Chart #2.

5. Enter Chart #2 at the randomly-determined frequency and read the corresponding positive or negative percent deviation from the mean.

6. Multiply the mean by the fractional deviation determined in step 5. If the deviation is positive, add the result to the mean; if negative, subtract the result from the mean. The answer is the number of new firms <u>actually</u> joining in the month being simulated.

<u>Example</u>

If, by the month being simulated, Chart #1 estimates 65 firms will have joined, and by the previous month Chart #1 estimates that 60 firms will have joined, then by subtraction, Curve #1 estimates that 5 new firms will have joined. Let 5 then be used for this month as the MEAN of Curve #2. Now, if the two-digit number extracted from the table of random digits is (let us say) 16, then entering Chart #2 at 16 on the vertical scale, we read a deviation of minus 25%. From step 6, 5 X .25 = 1.25. Since the deviation is negative, we subtract 1.25 from 5 to get 3.75. But this is not quite right, since reality excludes fractions of whole firms; we therefore round off the answer to the nearest whole number, which is 4, the <u>actual</u> number of new firms having joined in the month being simulated.

If the random number had been 84 instead of 16, the deviation would have been +25%, and 1.25 would have been added to 5, giving 6.25 or 6 firms actually joining.

The new firms are each checked using random digits to determine whether they are SP firms or CA firms. The service mix statement of each simulation is a proportion of CA firms to SP firms, e.g., 6 CA firms to 1 SP firm. Using this example to illustrate the method, the SP firms are then 1/7 of the total number of firms, or 14.3%. If there are 5 new firms in the month being simulated, then 5 two-digit numbers are extracted from the table of random digits (one two-digit number for each firm). If a random number is above 14, the firm is a CA firm; if 14 or less, the firm is an SP firm. Thus, once again we try to approach reality using random digits. This use of frequency distributions and break-points in conjunction with random numbers is known as the Monte Carlo method of simulation for obvious reasons.

The number of one-shot retrospective searches (O/S RS) in any month was held constant for all simulations at 14% of the total number of CA + SP searches to date. This assumption was chosen to approximate a growth rate proportional to the client growth rate and to give a number of monthly searches approximately halfway between ARAC's volume and that of DASC.

Referring to the first sheet of the flow chart, we have so far discussed the initial conditions, the determination of the number of new firms, and the number of O/S RS searches. Due to the time needed to program the model for computer simulation, these simulations have been performed manually. To do this in a reasonable length of time, the remainder of the model has been simplified compared to what was originally intended. The remainder has also been made completely deterministic, i.e., average figures have been used, as opposed to probability sampling techniques.

Following the "NO" branch of the "SP SEARCH?" determination, we see that a meeting will be arranged with a new non-SP firm which will be attended by the cognizant client personnel, the Applications Specialist, and Technical Specialists. The purpose of this meeting is to further determine overall company needs, to get a feel for company policies, to define the protocol that will be involved in servicing the company and to define the questions that will be serviced. The meeting is assumed to require 4 hours, with two hours of travel time.

It has further been assumed that most firms will have questions in one field of technology, with less than 25% of the non-SP client firms having questions covering more than one technological area. This assumption is based on the results of our questionnaire. To reflect this, an average figure of 1.25 Technical Specialists will attend these initial meetings.

Three other assumptions relevant at this point are (a) that the average number of CA questions per firm will be 3 for the first year and 5 thereafter; (b) that current awareness service will be preceded by a retrospective search for each question; and (c) that the meeting between the AS and TS's for unification of information after the client meeting should be able to be accomplished in the car going home.

The next step in the process (See Sheet 1 of the flow chart) sees the AS setting up an initial client profile, which will in all probability evolve (at least in part) into a standardized form. As the client/AS relationship ripens, the AS will add to and modify the initial profile. This step should take no longer than 15 minutes.

Simultaneously, the Technical Specialist is deriving the search strategy for the question. Assumed time is 20 minutes per question (based on personal experiments and conversations with KASC and ARAC personnel).

The AS sends a copy of his client profile to a woman who will be in charge of coordinating and controlling the flow of questions through the system. For the time being, she will be referred to as "the secretary." At the same time, the TS sends a copy of the search strategy to the secretary. She then assigns company and question code numbers, sets up a master company file folder and individual question work folders, and adds the question numbers to the monthly question status log sheet. Time for these actions by the secretary is estimated to be 15 minutes.

The strategy sheets are then sent to the computer group (2 minutes, clerk), where the cards are punched, the search is run, and the computer print-out sheet is sent back to the secretary.

The secretary logs in the print-out sheet in the status log, inserts the print-out sheets in their work folders (1 minute per question), and sends the folders to reproduction.

At this point, let us interject a monthly clerical activity· that of receiving, examining and filing the abstract cards from NASA. Assumptions: 6,500 abstracts per set of cards (conservative), 3 sets of cards (working file, master file, spare file for filling in partially illegible cards). Assume 8 seconds per abstract for checking legibility, completeness, and correctness of accession number order, and 30 minutes total for filing and miscellaneous associated tasks. Total clerk time is 31.77 man-hours.

After the work folders have been received by the reproduction clerks, the abstract cards are pulled (6 seconds per card), reproduced (15 seconds setup, 3 abstracts per page, 8 seconds per copy), and refiled (3 seconds per card), and the copies collated (1 second per page). The collated copies are put in the work folder and sent to the secretary (1 minute clerk time). Further assumptions: 15 abstracts per CA question, 100 abstracts per RS question.

The secretary logs in the work folders in the status sheet and sends them to the appropriate Technical Specialist (20 seconds per question).

The TS examines the drop and separates "hit" abstracts from "trash" abstracts. If necessary, he will make up a new strategy sheet. He then sends the work folder back to the secretary. Learning curves #3 and #4 have been generated to determine the time necessary for the operation. These were based on the fact that with practice the TS will develop proficiency, and furthermore, as the number of clients increases, duplicate or overlapping questions will be received.

The secretary logs in the work folder in the status sheet and fills in the number of hits and the hit-to-drop ratio in the spaces provided on the print-out sheet for each question. She then gives the work folder to a typist. (2 minutes per CA question, 4 minutes per RS question.)

The typist fills in a transmittal letter and a mailing envelope, stuffs, sends to mailing and sends the work folder back to the secretary. (3 minutes per question.)

The secretary logs in and files the work folder. (1 minute per question.)

Within a week at most, the Technical Specialist telephones the client interest center and discusses the results of the search (15 minutes per question.)

Once a month, the Applications Specialist visits the client firm (2 1/2 hours per firm, including travel).

Returning to the first page of the simulation flow chart, we follow the "YES" branch of the "SP SEARCH?" determination to page 'e'. The Applications Specialist meets with the new client firm (6 hours, including travel) and develops a profile. He writes up the profile and sends a copy to the secretary (15 minutes), who starts a company folder, assigns a company code number, and notifies the computer group of this new firm being added to the SP question. (15 minutes). From this point on, the search and other procedures are the same as for the CA and RS firms until the Technical Specialist evaluates the search.

The results of the Technical Specialist's evaluations are sent to the secretary, who logs them in and sends them to reproduction (1 minute secretary + 2 minutes clerk).

Enough abstract copies are run off to satisfy the requirements of the firms subscribing to the particular SP search, and these are sent to the secretary with the work folder (same reproduction time assumptions arefor CA and RS; assume 60 abstracts per SP question).

The secretary then proceeds as for the CA and RS searches; logging in the abstract packages, sending them on to the typist who prepares the mailing envelopes, sends the packages to mailing and returns the work folders to the secretary (same time assumptions as for RS and CA above).

Once a month the Applications Specialist visits the SP clients (2.5 hours per firm, including travel).

Requests for full documents are channeled to the secretary, who gets the work folder from the file, logs in the request, and sends the folder with the request form to the clerk responsible for the microfiche operation (4 minutes).

The clerk determines whether or not the microfiche card is on file (1 minute). If it is, she runs the required number of copies, assembles them, and sends them together with the work folder back to the secretary. (30 seconds per document to pull the cards, 15 seconds per page to blow back, 1 second per page to assemble, 2 minutes to send).

It was assumed that 50% of the time the microfiche cards would not be on file, due to the fact that approximately one half the documents are those indexed by AIAA. In this event, the microfiche clerk would send the folder back to the secretary who would have a typist type the appropriate request forms and then send them out. (2 minutes per document requested.)

Upon the arrival of the hard copy at the secretary's desk (whether from the clerk or from the outside) the secretary logs it in, and sends it to a typist (2 minutes), who types the transmittal forms (2 minutes). She then sends this to the secretary who logs it and sends it to mailing. (3 minutes)

Other Assumptions

1. Salaries:	Applications Specialist	-	$14,000 per year
	Technical Specialist	-	$6.72 per hour, equivalent to $14,000 per year on a 12 month basis

Secretary - $435 per month

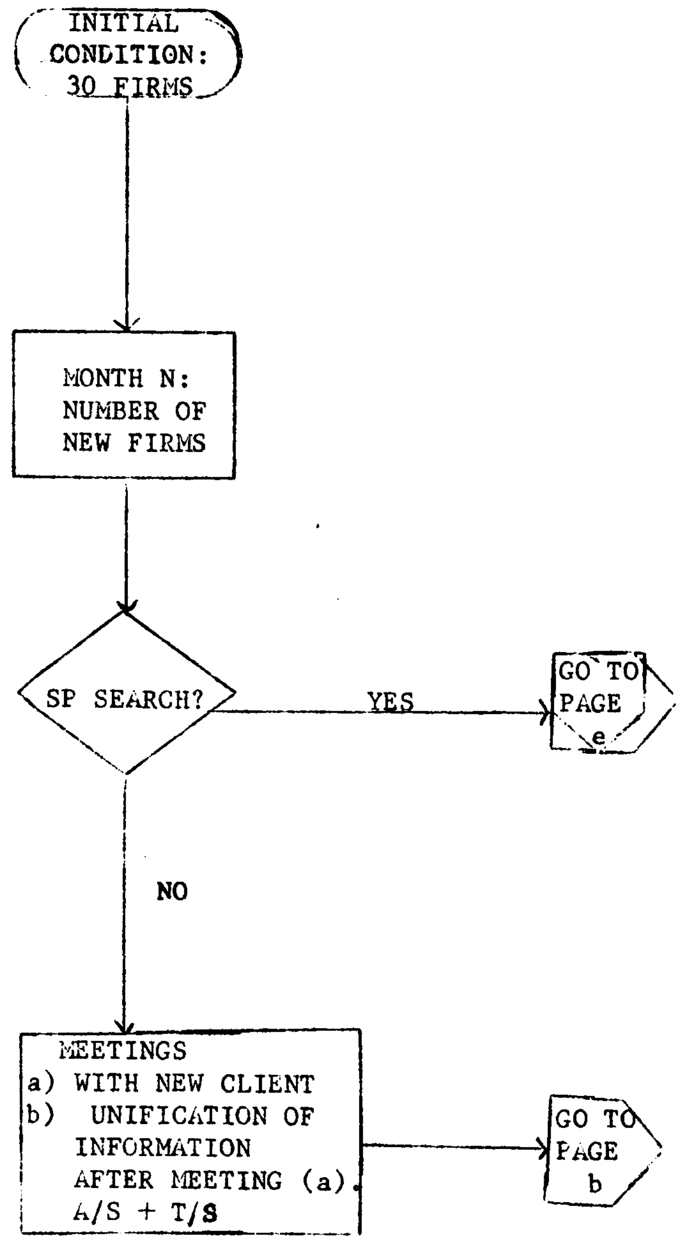
Clerk/Typist - $1.30 per hour

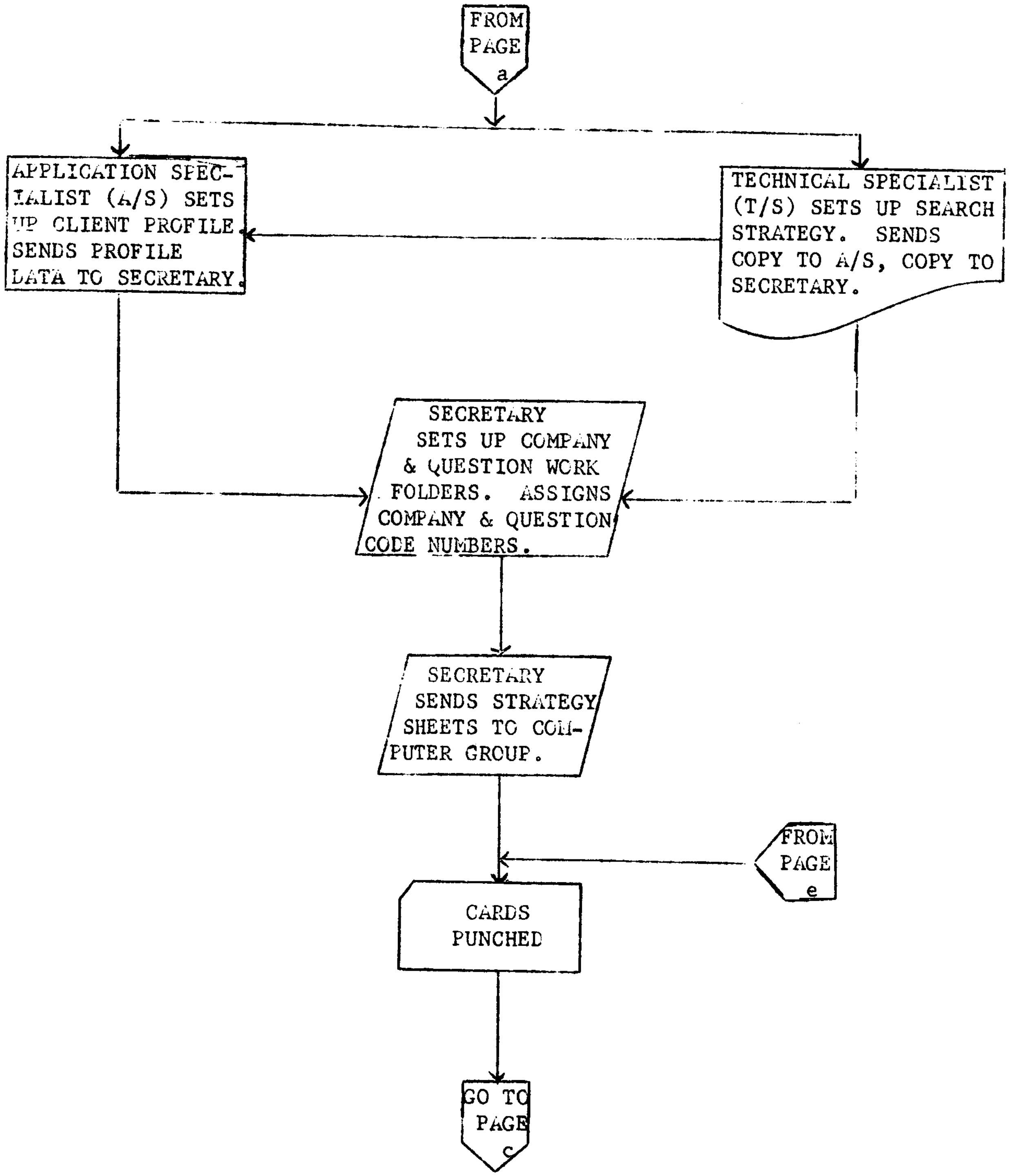
2. One SP question per SP firm, plus one SP question for every third CA firm. (The reasoning behind this is that the CA firms would find this to be a useful supplement to the regular CA questions. This idea came to light during a number of our discussions with firms who were interested in the RDC concept.)

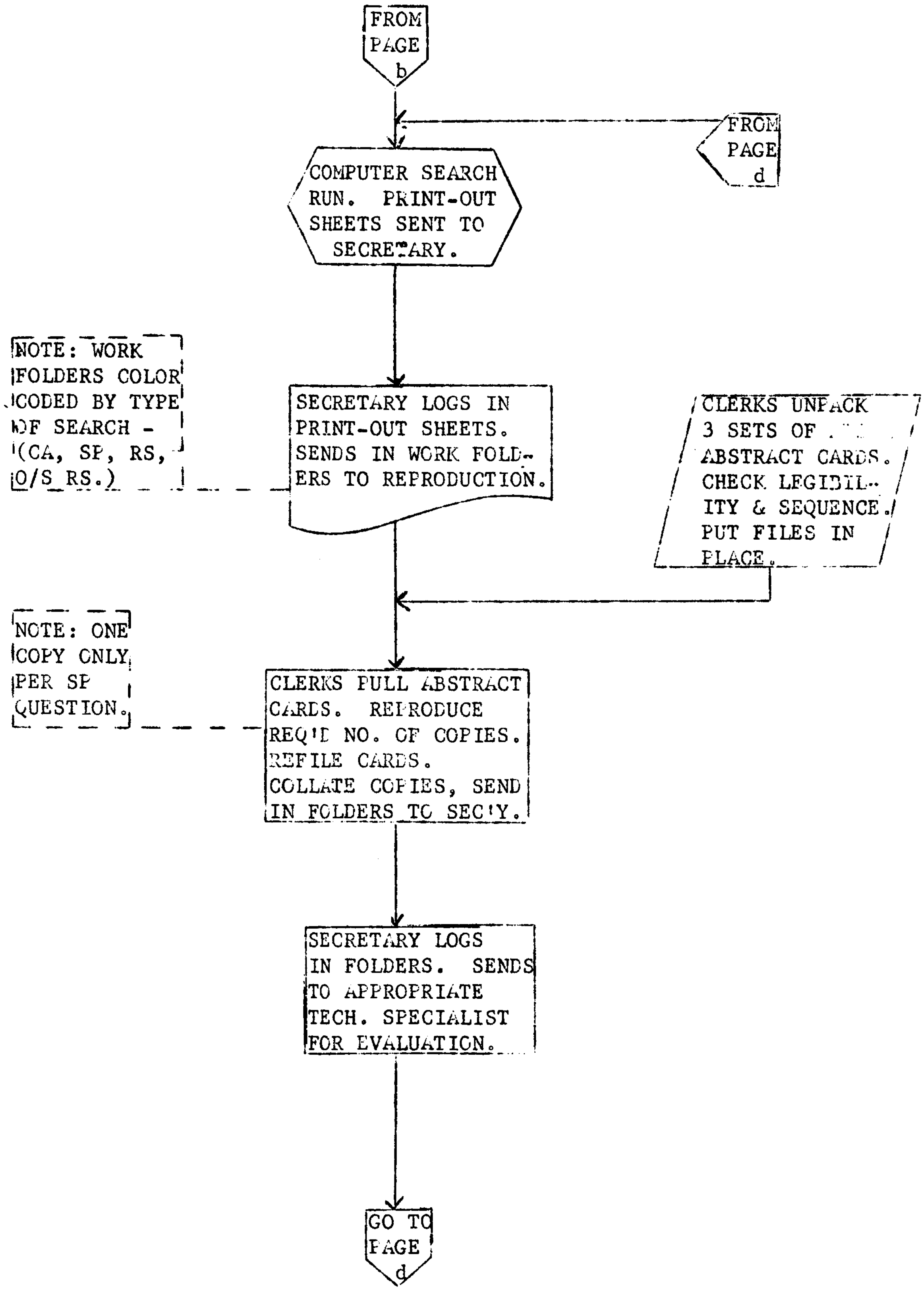
3. Reproduction cost per page of abstracts - $0.05

4. Microfiche blowback cost - based on Itek 18-24, $0.037 per document page (2 document pages per blowback page), with an average of 25 pages per document, plus monthly rental of $82. This rental figure has since been found to be low, the actual rental being $120.

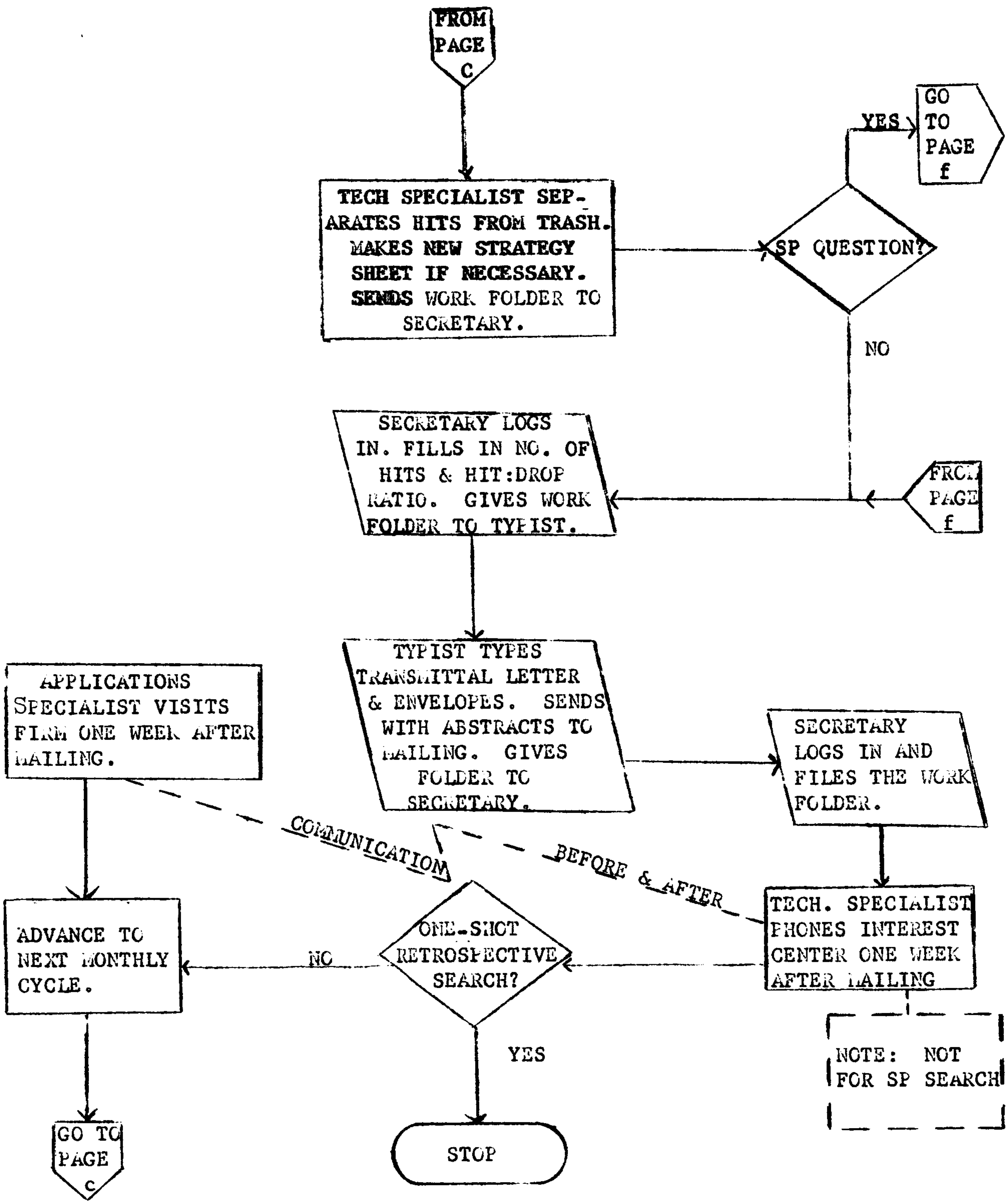
SIMULATION FLOW CHART

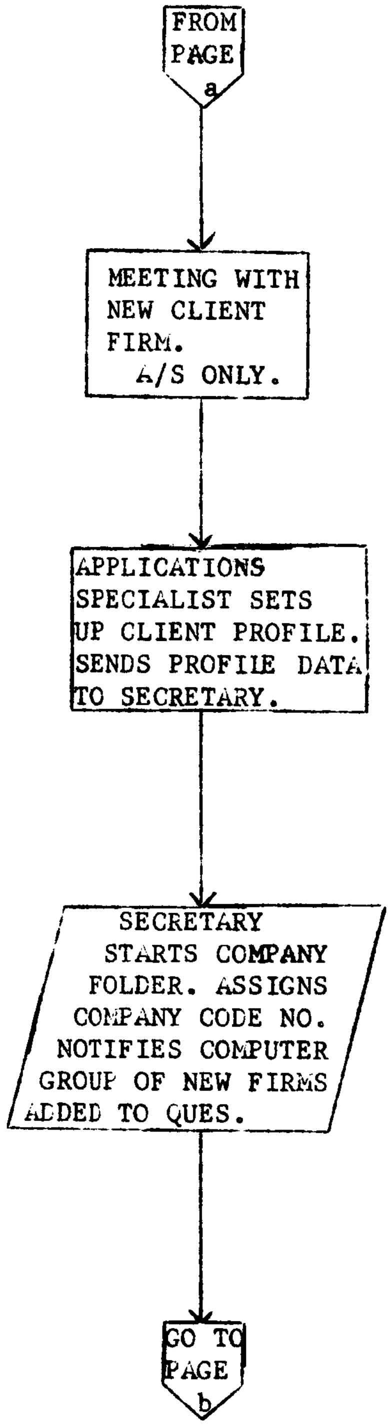


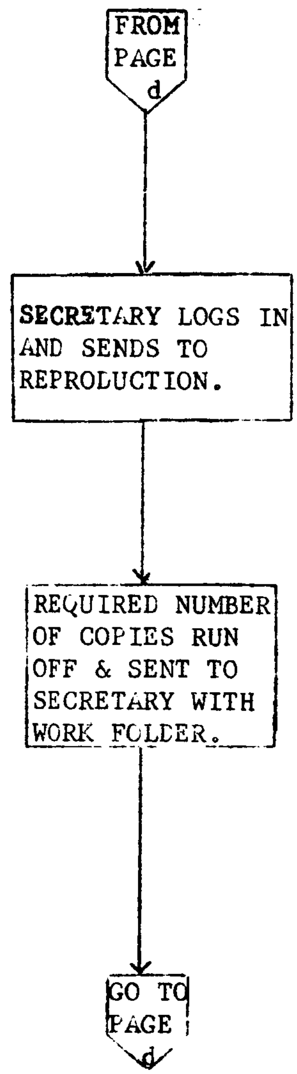

FROM PAGE a
APPLICATION SPECIALIST (A/S) SETS UP CLIENT PROFILE. SENDS PROFILE DATA TO SECRETARY.
TECHNICAL SPECIALIST (T/S) SETS UP SEARCH STRATEGY. SENDS COPY TO A/S, COPY TO SECRETARY.
SECRETARY SETS UP COMPANY & QUESTION WORK FOLDERS. ASSIGNS COMPANY & QUESTION CODE NUMBERS.
SECRETARY SENDS STRATEGY SHEETS TO COMPUTER GROUP.
FROM PAGE e
CARDS PUNCHED
GO TO PAGE c



FROM PAGE b
FROM PAGE d
COMPUTER SEARCH RUN. PRINT-OUT SHEETS SENT TO SECRETARY.
NOTE: WORK FOLDERS COLOR CODED BY TYPE OF SEARCH - (CA, SP, RS, O/S RS.)
SECRETARY LOGS IN PRINT-OUT SHEETS. SENDS IN WORK FOLDERS TO REPRODUCTION.
CLERKS UNPACK 3 SETS OF ABSTRACT CARDS. CHECK LEGIBILITY & SEQUENCE. PUT FILES IN PLACE.
NOTE: ONE COPY ONLY PER SP QUESTION.
CLERKS PULL ABSTRACT CARDS. REPRODUCE REQ'D NO. OF COPIES. REFILE CARDS. COLLATE COPIES, SEND IN FOLDERS TO SEC'Y.
SECRETARY LOGS IN FOLDERS. SENDS TO APPROPRIATE TECH. SPECIALIST FOR EVALUATION.
GO TO PAGE d


FROM PAGE c
TECH SPECIALIST SEPARATES HITS FROM TRASH. MAKES NEW STRATEGY SHEET IF NECESSARY. SENDS WORK FOLDER TO SECRETARY.
SP QUESTION?
YES
GO TO PAGE f
NO
FROM PAGE f
SECRETARY LOGS IN. FILLS IN NO. OF HITS & HIT:DROP RATIO. GIVES WORK FOLDER TO TYPIST.
TYPIST TYPES TRANSMITTAL LETTER & ENVELOPES. SENDS WITH ABSTRACTS TO MAILING. GIVES FOLDER TO SECRETARY.
SECRETARY LOGS IN AND FILES THE WORK FOLDER.
APPLICATIONS SPECIALIST VISITS FIRM ONE WEEK AFTER MAILING.
COMMUNICATION BEFORE & AFTER
TECH. SPECIALIST PHONES INTEREST CENTER ONE WEEK AFTER MAILING
NOTE: NOT FOR SP SEARCH
ONE-SHOT RETROSPECTIVE SEARCH?
NO
YES
ADVANCE TO NEXT MONTHLY CYCLE.
GO TO PAGE c
STOP


FROM PAGE a
MEETING WITH NEW CLIENT FIRM. A/S ONLY.
APPLICATIONS SPECIALIST SETS UP CLIENT PROFILE. SENDS PROFILE DATA TO SECRETARY.
SECRETARY STARTS COMPANY FOLDER. ASSIGNS COMPANY CODE NO. NOTIFIES COMPUTER GROUP OF NEW FIRMS ADDED TO QUES.
GO TO PAGE b


FROM PAGE d
SECRETARY LOGS IN AND SENDS TO REPRODUCTION.
REQUIRED NUMBER OF COPIES RUN OFF & SENT TO SECRETARY WITH WORK FOLDER.
GO TO PAGE d

APPENDIX D

EXHIBIT I

A. Determination of Search Time

Four graduate students were given two 7-term questions each. They were to search for relevant accessions in one volume of the STAR Cumulative Index. The respective search times were then multiplied by 8 (4 volumes each of STAR and IAA) and then averaged.

A similar experiment was performed for a current awareness type search. Average search times were 14.0 minutes for a CA search and 9.01 hours for an RS search. These results will be discussed further below.

B. Determination of Per-Hour Cost of Manual Searching.

1. Assume searching to be done by graduate students with scientific and/or technical background.

Wages (hourly)	\$2.50
University Contribution to fringe benefits @ 6.5%	.163
University Indirect Cost @ 38%	1.012
Total hourly cost	\$3.675

2. Other Costs

   a. Learning - Assume that a new searcher operates at 50% efficiency during his first month of employment, 75% during his second, and 90% thereafter. Assume that the average graduate student searcher were to work for an RDC for 9 months. The learning process would increase the average cost of his performing searches to \$4.471.

   b. Training - if an experienced searcher were assigned to assist the new searcher during the first two months, his efficiency would fall off to 50% in the first month and 75% in the second. This would further increase the average hourly cost to $4.695.

3. Search Times

From the above discussion of efficiency, we can examine the experimental search times. The CA time of 14.03 minutes and the RS time of 9.01 hours may be thought of as the 50% efficiency point. At 100% efficiency, the times would be reduced to 7.015 minutes and 4.505 hours, respectively. The average efficiency of the searcher may be estimated to be $3.675 ÷ 4.695, or 78.2%, at which level, then, the search times would be increased to 8.97 minutes and 5.76 hours, respectively.

4. Number of Searchers

It is estimated from our simulations that, assuming a growth to 200 firms at the 48th month, with 10 CA firms per SP firm, we would perform a total of 28 RS searches and 156 CA searches in the 12th month. Total search time required would be (28 x 5.76) + 156 x (8.97/60) = 184 man-hours. Similarly, for the 24th month, 533 man-hours would be required, for the 36th month, 759 man-hours and for the 48th month, 864.

Assuming a 20 hour work week by the students and 4 1/3 weeks per month, the number of students required would be 3, 7, 9, and 11 for the 12th, 24th, 36th and 48th months respectively, except that a minimum of five would be used, due to the needs for diversified knowledge.

5. Additional Costs

Furniture: $200 per man, amortized over 5 years	$0.038
Payroll and scheduling expense	

(including addition of clerk full time @ \$1.80 x 1.065 x 1.38 = \$2.645 per hour spread over 11 men)	0.240
Floor space: Include in 38% University indirect cost. Total additional	0.278
Add \$4.695	4.695
Total cost per hour	\$4.973

Monthly Cost of Searching

Month	Manual	Center Computer	In-house Computer
12	\$ 915	\$1674	\$2100
24	2651	3181	2000
36	3775	3640	2000
48	4297	3860	2000

EXHIBIT II

Applications Specialist

a. Functions

(1) To acquire client firms.

(2) Together with TS's, to meet with new client firms to determine the extent of the service, and to define the service.

(3) To develop client firm innovation profiles, including:

(a) Optional Information Services being provided,
(b) Company characteristics (size, sales, products, officers, etc.),
(c) Company innovation needs
(d) Company personnel responsible for these innovation needs,
(d) Definition of company goals and purposes (broad, generic), and real resources.

(4) To coordinate TS activities within his firms.

(5) To acquire feedback from both the TS and from the client personnel on the OIS services rendered.

(6) To satisfy client innovation needs.

(a) thru regular meetings with TS's
(b) thru scanning of Tech Briefs and other sources (elaborate)

(7) To acquaint SP clients with full value of RDC.

(8) To assess the management interests of client personnel and to get pertinent management research literature into their hands.

(a) To identify special need groups for workshops in management technology.
(b) To set these workshops up in conjunction with other AS's and RDC's.
(c) To act as referral agent for client when necessary.

b. Requirements - (minimum)

(1) Education: Bachelor's degree in engineering or sciences. One year postgraduate work in Business Administration.

(2) Industry: One year in Technical capacity, one year in administrative or sales capacity.

(3) Personality Traits:

(a) "Self-starting," agressive, organized.
(b) Imaginative.
(c) Ability to deal with people on a management level and on a technical level with equal ease.
(d) Pleasant; able to keep a conversation going (preferable to him rather than from him.)

c. Salary

Range $11,000 to 15,000 $/year. Figure used in simulation, $12,600 per year.

d. Base

In the area which he services.

e. Workload

The assumption used in the simulations was 28 hours per week.

EXHIBIT III

Information Specialist

a. Functions

(1) To be responsible for "one-shot" retrospective searches. To speak by telephone with technical or scientific personnel of the requesting firm. To define the question with these personnel.

(2) To develop a computer search strategy for each of these questions. To review the results of the computer search and refine the strategy if necessary.

(3) To provide assistance to Technical Specialists when required. (e.g. backup information from non-NASA sources, search strategy, design, etc.

(4) To become an in-house authority on the files and their contents, and on designing search strategies for utilizing files.

(5) To attend regular meetings with the TS's and the AS's at which are discussed:

(a) any problems that they might have run into that would be of general interest;
(b) any information that might be of interest.

b. Requirements

(1) Ph.D in sciences or engineering

(2) Scientific generalist by nature and preferably by training.

(3) One year industrial experience preferred.

(4) Thorough and methodical

c. Salary

$11,000 - $15,000 range; $12,000 per year used in simulation.

d. Base

At University of Connecticut

e. Workload

37½ hour week, 80% efficiency.

EXHIBIT IV

Technical Specialist

a. Functions:

(1) To meet with technical and/or scientific personnel of a client company whose problems or questions fall within the TS's areas of expertise. To define with these personnel their problems or questions, to explore the ramifications of the questions, to redefine if necessary.

(2) To develop a computer search strategy for the above questions. To review the results of the computer search and refine the strategy if necessary.

(3) To review the results of the search with the client personnel and redefine the question and/or refine the search strategy if necessary.

(4) To evaluate the results of standard profile searches in his area of expertise, and to refine their search strategies when necessary.

(5) To attend regular meetings with the other TS's and the AS's at which art discussed:

(a) any problems the TS's might have run into that would be of general interest;
(b) any information that might be of interest;
(c) AS needs and answers to AS needs.

(6) To call clients once per month. To visit at least annually.

b. Requirements

(1) Faculty member of engineering or science school of accredited New England university.

(2) Master's degree in subject area minimum; PhD or equivalent preferred.

(3) Three years minimum teaching experience.

(4) One year industrial experience minimum preferred.

c. Wage

Part-time, $6.283 per hour, equivalent to $13,000 per year

d. Base

Typically at his university. Relations with academicians are envisioned at other New England universities so that the various geographic areas may be efficiently serviced.

e. Workload

Maximum of eight hours per week with 80% efficiency was assumed in the simulations.

APPENDIX E

EXHIBIT I

NEW ENGLAND RESEARCH APPLICATION CENTER
UNIVERSITY OF CONNECTICUT
STORRS, CONNECTICUT 06268

The five billion dollars a year that NASA is spending on the space program results in research and innovations that are important to your company. The knowledge demanded in placing a man on the moon requires research covering practically the entire spectrum of physical and biological sciences, as well as significant work in management technology. How can this resource be exploited for profit? The answer has been the formation of dissemination centers in various parts of the country under NASA's auspices.

The New England Research Application Center has been established at the University of Connecticut for the express purpose of making available technological advances which meet a company's specific needs. The transfer process involves two distinct goals. One of these is the identification and evaluation of product or process innovations that may be used within the firm or which are themselves marketable. The other goal is the identification of areas of technology of special interest to the company where a continuing review of relevant research findings is desirable.

It is with this latter goal that we need your help. In order to serve the New England technical community adequately, we need to determine those areas of technological interest of greatest concern. We have enclosed a questionnaire, to be completed anonymously, that will help us immensely in developing programs most advantageous to New England.

A leaflet describing the Center's objectives and services has also been enclosed for your information. Your assistance in providing us with the data requested will be very much appreciated.

Sincerely,

S. William Yost
Director

Enclosures

NERAC

PHONE 429-9321
EXTENSION 1125

EXHIBIT II

THE FOLLOWING QUESTIONNAIRE IS ANONYMOUS,
AND ALL ANSWERS WILL BE HELD STRICTLY CONFIDENTIAL.

QUESTIONNAIRE

Instructions: Please answer question 1. Then if your time permits, complete question 2. Regardless of whether or not question 2 has been aswered, please return this questionnaire with your answer to question 1 in the enclosed self-addressed envelope.

1. In which specific areas of technological research, advancement, and innovation would your firm be most interested? List as many as you can. Please be as specific as possible.

   EXAMPLE: Do NOT list "Solid State Electronics."
   List instead "Methods of growing semi-conductor crystals."

   EXAMPLE: Do NOT list "Welding."
   List instead "Nondestructive testing of weld integrity, especially theories or techniques with the potential for high volume testing of large welds."

   EXAMPLE: Do NOT list "Human Physiology."
   List instead "Techniques of reducing the need of the human body for sleep for extended periods of time."

   a. ....

   ....

   ....

   b. ....

   ....

   ....

   c. ....

   ....

   ....

2. Select from the categories on the next page those most nearly approximating your firm's field(s) of endeavor. If more than one, please number them in order of importance to the firm (place a one next to the category of greatest importance, a two next to the category of next greatest importance, etc.).

INDEX OF TECHNICAL INTERESTS

01 Aeronautics ☐

- ☐ Aerodynamics
- ☐ Air Facilities
- ☐ Aircraft
- ☐ Aircraft Flight Control and Instrumentation

05 Behavioral and Social Sciences ☐

- ☐ Administration and Management
- ☐ Documentation and Information Technology
- ☐ Human Factors Engineering
- ☐ Personnel Selection, Training, and Evaluation
- ☐ Psychology (Individual and Group Behavior)

06 Biological and Medical Sciences ☐

- ☐ Biochemistry
- ☐ Bioengineering
- ☐ Bionics
- ☐ Clinical Medicine
- ☐ Food
- ☐ Medical and Hospital Equipment
- ☐ Medical Electronics
- ☐ Medical Instrumentation
- ☐ Protective Equipment

08 Earth Sciences and Oceanography ☐

- ☐ Geology and Mineralogy
- ☐ Mining Engineering
- ☐ Seismology
- ☐ Soil Mechanics

09 Electronics and Electrical Engineering ☐

- ☐ Circuits
- ☐ Components
- ☐ Computers
- ☐ Electronic and Electrical Engineering
- ☐ Information Theory
- ☐ Microelectronics
- ☐ Subsystems
- ☐ Telemetry
- ☐ Transducers

10 Energy Conversion ☐

- ☐ Batteries
- ☐ Conversion Techniques
- ☐ Energy Storage
- ☐ Fuel Cells
- ☐ Power Sources

11 Materials ☐

- ☐ Abrasives
- ☐ Adhesives and Seals
- ☐ Ceramics, Refractories, and Glasses
- ☐ Coatings, Colorants, and Finishes
- ☐ Composite Materials
- ☐ Fibers and Textiles
- ☐ Metallurgy and Metallography
- ☐ Miscellaneous Materials
- ☐ Oils, Lubricants and Hydraulic Fluids
- ☐ Plastics, Reinforced Plastics
- ☐ Rubbers
- ☐ Solvents and Cleaners
- ☐ Wood and Paper Products

13 Mechanical, Industrial, and Civil Engineering ☐

- ☐ Air Conditioning, Heating, Lighting and Ventilation
  - Refrigeration
- ☐ Civil Engineering
  - Water Purification
  - Water Treatment
- ☐ Construction Equipment, Materials and Supplies
- ☐ Containers and Packaging
- ☐ Couplings, Fittings, Fasteners and Joints
- ☐ Ground Transportation Equipment
- ☐ Hydraulic and Pneumatic Equipment
- ☐ Industrial Processes
  - Casting
  - Extrusion
  - Fiber Metallurgy
  - Forging
  - Machining
  - Metal Forming
  - Numerical Control
  - Powder Metallurgy
  - Quality Control
  - Welding
- ☐ Machinery and Tools
  - Bearings
  - Dies
  - Gears
- ☐ Pumps, Filters, Pipes, Fittings, Tubing, and Valves
- ☐ Safety Engineering
- ☐ Structural Engineering

14 Methods and Equipment ☐

- ☐ Cost Effectiveness
- ☐ Laboratories, Test Facilities, and Test Equipment
- ☐ Photographic and Reproduction Equipment
- ☐ Recording Devices
- ☐ Reliability
- ☐ Value Analysis

20 Physics ☐

- ☐ Acoustics
- ☐ Cryogenics
- ☐ Fluid Mechanics
- ☐ Magnetism
- ☐ Masers and Lasers
- ☐ Optics
- ☐ Plasma Physics
- ☐ Solid Mechanics, Stress Analysis, Vibration and Shock
- ☐ Solid State Physics
- ☐ Thermodynamics and Heat Transfer

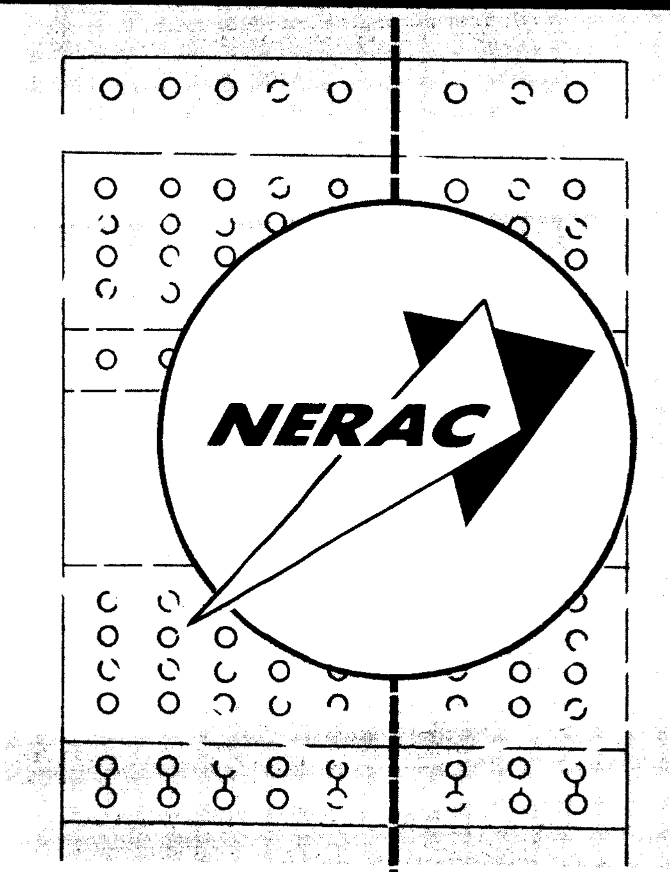
21 Propulsion and Fuels ☐

- ☐ Combustion and Ignition
- ☐ Electric Propulsion
- ☐ Fuels
- ☐ Jet and Gas Turbine Engines
- ☐ Reciprocating Engines
- ☐ Rocket Propellants

EXHIBIT III

Leaflet Used in Letter (Exhibit I)
and for
General Distribution

INFORMATION for INDUSTRY



NERAC — The New England Research Application Center

NEW ENGLAND RESEARCH APPLICATION CENTER
RESEARCH
RETRIEVAL
APPLICATION
UNIVERSITY OF CONNECTICUT

EXHIBIT III

Leaflet Used in Letter (Exhibit I)
and for
General Distribution

INFORMATION for INDUSTRY....

item: It is estimated that man has doubled the entire body of knowledge in the past 20 years.

item: More than half the research and development conducted in the history of civilization has occurred in the past 10 years.

item: Better than 5,000,000 scientific and technical articles are published annually in 100,000 journals.

WHO IS *NERAC*?

NERAC, the New England Research Application Center, is a venture of the University of Connecticut School of Business Administration seeking NASA sponsorship.

WHERE IS *NERAC*?

NERAC is located in the Greater Hartford area in Connecticut, to service the business, academic, and professional communities of New England.

WHAT IS *NERAC*?

NERAC is an organization devoted to aiding its clients in discovering, understanding and utilizing the results of government sponsored research. To perform this task, NERAC draws on the authoritative skills of New England academicians. In addition, its computerized information center has access to the vast files of NASA and other government agencies but is **not** limited to them.

HOW CAN *NERAC* HELP YOU?

NERAC will offer various kinds and degrees of service to meet the needs of firms with widely differing sizes and interests so that all may take advantage of its facilities and expertise at a minimum of cost.

Technical Services

Retrospective Searches: Clients firms can have comprehensive literature searches performed by NERAC upon request. A NERAC technical consultant will assist the client in defining the problems or interest areas and their ramifications, initiate the search, and evaluate the results. A retrospective search such as this will be a standard preliminary to the current awareness program described below for all new client firms.

Current Awareness Searches: Thousands of technical reports and documents will be received by NERAC and searched selectively to provide its client firms with the latest scientific and technical developments that are pertinent to their interests. The results of these searches will be evaluated by NERAC's technical consultants and sent monthly in abstract form to its clients. If complete documents are then desired, one-day service will normally be possible.

Computer Programs: NERAC has access to files of computer programs to aid its client firms in their scientific and technical investigation.

NASA Technical Briefs and Reports with commercial and industrial potential will be distributed monthly to appropriate client interest groups.

Management Services

Reports and workshops in Management Research and Technology will be made available to aid client personnel in keeping abreast of management techniques and literature being developed under government auspices.

Product Analysis Service: NERAC will provide preliminary analyses of possible commercial applications, market potential, and resources required to exploit selected products or process innovations described in NERAC-issued bulletins.

NERAC will furnish periodically NASA Technical Briefs and Reports to designated members of management, e.g., those who are involved in product development and process improvement.

WHY SHOULD YOU USE *NERAC*?

Personal Contact: NERAC's technical consultants work with the clients in defining their interests and problems, explaining and elaborating reports, and contacting original sources.

Time Saving: Valuable time of scientists and technical people is not spent in reading journals to keep up with their field, or by painful, exhaustive literature searches.

Wasteful duplication of research can be minimized.

Insurance is provided against missing important developments in highly specialized areas.

The right people are aware of the fact that specific information exists, and that it can be rapidly obtained.

Significant developments in other fields are not lost to the researcher.

Economical: Varying kinds and degrees of services are available, suited to the needs and resources of a wide variety of potential users.

EXHIBIT IV

EXAMPLES OF RESPONSE TO QUESTIONNAIRE

Improved underwater deep penetration seismic profiling systems for underwater mineral exploration

Methods of finishing ball raceways in bearings to RMS values of 2 microinches or less.

Analytical representation of cutting forces and tool deflection during metal removal process

Electrodeposition of precious metals, especially properties and performance of deposits

High temperature saturants/watings compatible with inorganic electrical wire and cable insulations (asbestos, glass, quartz, et.) that will provide moisture/fluid resistance <u>and</u> flexibility after long term exposure up to 1200°F

Making dispersed phases in metallic materials by internal oxidation

Systems application of lasers for communications, radar, etc., and basic advances in laser technology

Sensors for the measurement and subsequent control of low forces and strains

Atomic frequency standards and oscillators with excellent spectral purity

Physical Optics - The application of information theory to imaging and image interpretation systems

Hologram photography for the study of aerosols and the particle size distribution of liquid droplets in gas streams or small solid particulates in liquids

Design and fabrication techniques for the construction of large controlled environment enclosures with electromagnetic transmissive walls

Development for laboratory to small pilot scale of physiologically active amines

Non-destructive measurement of tooth enamel porosity

Hydrolysis techniques for microgram quantities of bacterial polysaccharides

EXHIBIT V

The Commonwealth of Massachusetts
University of Massachusetts
Amherst 01003

COMTECH
Commonwealth Technical Resource Service

Engineering Building
Tel: 413-545-2063

November 25, 1966

New England Research Application Center
Box U-41N, University of Connecticut
Storrs, Connecticut

Att: Mr. William Yost, Director

Dear Bill,

Let me thank you and your associates, on behalf of Hal and myself, for the very pleasant and useful meeting we had on November 21. I think we both understand a good deal more about the programs we are attempting to initiate.

While there probably is going to be some overlap, we came away with the feeling that there is no fundamental conflict between the efforts we are going to make. In fact, it is rather clear that we can represent complementary resources and we shoud strive to cooperate with that view in mind.

Enclosed is a copy of the FIVE YEAR PLAN/1966-1970, Public Law 89-182, for the Commonwealth of Massachusetts. I should like you to look this over and then respond with an indication of the ways and means in which you think NERAC activities can operate as a resource for our program. Please try to be as specific as possible, indicating the mechanism you can visualize for interplay and specifying the limitations which you can foresee NERAC having in its informational capabilities relative to the informational demands of the STSA users.

I have issued a report to the other State's of New England regarding our interview and encouraging them to adopt a positive attitude toward NERAC in support of its value to us and in terms of the feasibility report which you will soon be presenting. I have not yet been able to clarify the December 9 date for Sam to appear at our Regional meeting, but this is simply a matter of communication among the several people that have to be involved in that meeting and so I have to leave that date, as yet, tentative.

With very kind regards.

Very truly yours,

Howard D. Segool

Howard D. Segool
Director, COMTECH

HDS/ak
Enc.

EXHIBIT VII

RESEARCH MANAGEMENT ASSOCIATION

AN ASSOCIATION OF SMALL, RESEARCH BASED, BOSTON AREA COMPANIES

BOARD OF GOVERNORS

DR. ARTHUR S. OBERMAYER, CHAIRMAN
MOLECULON RESEARCH CORPORATION

DR. PHILLIP D. BOGDONOFF
BIO-RESEARCH CONSULTANTS, INC.

MR. WILLIAM A. FAXON
COMSTOCK & WESCOTT, INC.

MR. ROBERT O. JOHNSON
BOLT, BERANEK & NEWMAN, INC.

LEE A. STRIMBECK, ESQ.
CHROMERICS, INC.

139 MAIN STREET
CAMBRIDGE, MASS., 02142
TEL: 547-2353

December 1, 1966

Mr. S. William Gost
Director, New England Research
Applications Center
Box U-41N
University of Connecticut
Storrs, Connecticut

Dear Mr. Gost:

This letter is an expression of interest by the Research Management Association in seeing that a NASA Regional Dissemination Center (RDC) be established for the New England area. We feel such a center would provide a valuable information source for the smaller research and development corporation. We would expect as an organization to provide requirements information to such a center and feed back, so that the RDC can be responsive to the needs of the smaller R&D company.

The type of operation described in the NERAC literature would, as a first approximation, seem responsive to the needs of our member companies. Therefore, we endorse the establishment of an RDC for New England along the lines specified in the NERAC Service Memos and Brochure.

Very truly yours,

RESEARCH MANAGEMENT ASSOCIATION

Arthur S. Obermayer

Arthur S. Obermayer
Chairman

ASO/LD

EXHIBIT VIII

LETTER OF INTENT FOR MEMBERSHIP AS AN ASSOCIATED BUSINESS FIRM IN

THE UNIVERSITY OF CONNECTICUT RESEARCH APPLICATION CENTER

New England Research Application Center (NERAC)
Box U-41N, University of Connecticut
Storrs, Connecticut 06268

Gentlemen:

The ____
(name and address of business firm)

____

Hereinafter referred to as the Associate, by this letter of Intent signifies an intent to contract for membership as an associated business firm in the New England Research Application Center on and after the Center's operational date. This operational date is assumed to be 15 January 1967, but in any case the operational status of the Center will act as the condition precedent to activate this agreement. NERAC will notify the Associate within fifteen(15) days after this operational date. The period of this contract will be for one year, beginning with said operational date; services to be provided, price and method of billing will be in accord with the attached price schedule and as specified below.

The Associate agrees to contract for the following services:__________

____
(list services to be provided, including interest areas, if known,

____.
method of billing and price)

The Associate reserves the right to contract for additional services at any time. Such services shall be provided within the appended price schedule. However, NERAC reserves the right to renegotiate the terms and conditions of its service at the end of the first operational year and at each yearly renewal date thereafter upon terms and conditions reasonable in terms of the Associate's use of the facilities and services of the Center during the previous twelve month period.

The University of Connecticut and the Government make no warranty as to the rights in intellectual property to be supplied under this contract other than that best efforts have been used to ascertain said rights, if any, and to so indicate to the Associate.

This letter of intent when accepted by the New England Research Application Center shall constitute an agreement contingent upon the Center's becoming operational on or before 30 April 1967 and shall remain in effect throughout the Center's first operational year.

Prior to said operational date, the Associate may request information from the Center. These requests will be serviced, using best efforts, in a manner consistent with the Center's operational status at the time of request. Any expense incurred thereby will be subsumed under this contract, no additional charge being made therefor.

(date)

(name)

(title)

EXHIBIT IX

FIRMS WHO HAVE SIGNED A LETTER OF INTENT

Ames Textile Corporation

Arcon Corporation

Astro Dynamics, Incorporated

Avco Corporation - Missiles, Space and Electronics Group

Cabot Corporation

Danco - A Division of Nicholson File Company

Dynamics Research Corporation

Harris Manufacturing Company

Honeywell - Computer Controls Division

Invac Corporation

Jarrell-Ash Company

Lowell Wrench Company

RF Systems, Incorporated

Rogers Corporation

Spectrum Systems, Inc.

Thomas Smith Company

Waters Associates, Incorporated

Wayne-George Corporation

Worcester Valve Company

Wyman-Gordon Company

Geodyne Corporation

Ion Physics